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ENVIRONMENTAL TEST REPORT ON THE TARGET DETECTOR DSU-15/B.(U)
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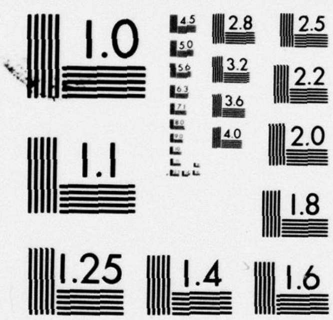

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NWC Technical Memorandum 2523

Environmental Test Report on the Target Detector DSU-15/B

by

L. J. Huber
Fuze Project Branch III
Development Division II
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JUNE 1975

NAVAL WEAPONS CENTER
China Lake, California 93555

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DOCUMENT SUMMARY SHEET

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Completion of Summary Sheet is Optional – Please Type All Information – See Instructions On Reverse

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	10 MFR AND H4 CODE NO.	11 MFR PART NO.	12 IND/GOVT STD NO.	13 TOTAL TESTED	14 EXCEEDED MFR CATALOG SPECS YES	NO
A	SBRC	DSU-15(XCR-2)/B		84		
B						
C			(9) Technical memo.			

15	SPECS, ETC, REQD TO UTILIZE DOCUMENT	ENCL	SUBMITTED AS/WITH GIDEP INDEX/ACCESS NO.
A	TN 3012-1-73	x	
B	(10) L. J. Huber		(14) NWC-TM-2523
C			

16 ITEM	TEST OR ENVIRONMENT	PER SPEC	SPEC PARAGRAPH METHOD/CONDITION	ENVIR CODE	NO. TESTED	NO. FAILED
A11	Acceptance Testing		Room Temperature	Y	84	0
A1	Acceptance Testing		High & Low Temp.	TU	77	12
A2	Temperature Shock	A	3.5	T/U	40	3
A3	Mechanical Shock	A	3.6	S	44	0
A4	Vibration	A	3.11	V	70	20
A5	Humidity Tests	A	3.12	M	10	0

17. SUMMARY

Contains the results of environmental qualification testing of prototype DSU-15/B Target Detectors.

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This document Supersedes E096-2283.

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16 ITEM	TEST OR ENVIRONMENT	PER SPEC	SPEC PARAGRAPH METHOD/CONDITION	ENVIR CODE	NO. TESTED	NO. FAILED
A6	Low-Temp. Storage and Low-Pressure/Low-Temp. Operate	A	3.13, 3.14, 3.15	P/U	5	1
A7	High-Temp. Storage	A	3.16	T	4	0
A8	Transportation Vibration	A	3.7	V	3	0
A9	Drop Test	A	3.8		2	1
A10	Acoustic Noise	A	3.9	N	2	1

17. SUMMARY

FOREWORD

Environmental qualification testing of the prototype DSU-15/B Target Detector was completed in July 1974, under AirTask A259-5108/216-6/1259-000-001. This report contains the results of these tests, which have been presented to the NWC Design Review Committee as part of and in conjunction with the Sidewinder AIM-9L guided missile subsystem.

This report is released at the working level and is not to be used as authority for action.

Hans D. Pieper
Head, Development Division II
Fuze Department
13 May 1975

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ABSTRACT

INTRODUCTION

Specification AS-2718 (Environmental Design Criteria and Test Plan for the Sidewinder (AIM-9L) Guided Missile Subsystem) contains the environmental qualification requirements for the DSU-15/B target detector (TD). Appendix II of AS-2718 specifies only the minimum testing required to provide environmental and safety qualification of the prototype hardware. Statistically, AS-2718 requires only a small number of TDs to be tested in accordance with the AS-2718 test requirements. The NWC Fuze Department believed that additional quantities should be tested to achieve a higher level of confidence in meeting the environmental requirements. AS-2718 authorized the preparation of more detailed test procedures, using the tests described in AS-2718 as guidance. Also, because missile guidance sections were not available for the qualification tests until relatively late in the AIM-9L development program, a separate qualification test program for fuzes only was planned by the Fuze Department. This program is documented in TN 3012-1-73, dated 15 January 1973, and was used to find and correct any deficiencies in the fuze design or manufacture. Whenever the test program revealed such deficiencies, the tested item was reworked. Subsequent testing was performed to verify that the deficiency was corrected (see Appendix A of this document).

ABSTRACT

The environmental tests specified in TN 3012-1-73 (see Appendix B of this document) were patterned after preliminary versions of the test requirements now contained in AS-2718, Appendix II. Differences between these two documents exist because changes were made in the qualification test requirements before the specification was authenticated. In addition, deviations from TN 3012-1-73 were made, in the best interest of the program, as testing progressed and TD problem areas were encountered.

All 52 prototype TDs fabricated under Contract N00123-73-C-0256 by Santa Barbara Research Center (SBRC), Santa Barbara, Calif., were subjected to these environmental acceptance tests, which were conducted at the Naval Weapons Center (NWC).

TEST SEQUENCE

Figure 1 shows the testing sequence for the 52 TDs, where the failures occurred, and at what point the units were removed from the test sequence for other program tests.

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Twenty-four of the 52 TDs were returned to the manufacturer for rework, after failing at least one of the tests of Figure 1. Each of the reworked units was subjected to additional testing, as shown in Figure 2. Figure 3 is a continuation of Figures 1 and 2. Six TDs were reworked and retested more than once. Figure 4 is a detailed breakdown of the captive and flight vibration blocks of Figures 1 and 2.

Test results for each TD are documented in Appendix A.

Definitions of the notations used in Figures 1 through 4 are as follows:

- XX = Number (quantity) of TDs
- R = Returned to SBRC for rework
- F = Failed testing
- A = Returned to SBRC for analysis
- 9L = AIM-9L missile flight tests
- 9H = AIM-9H missile flight tests
- HIP POC = Warhead flight test against antiship missiles
- REL = Reliability demonstration tests in accordance with NWC Memo 334-074-74, 1 November 1974
- F-15 = TDs containing dummy thermal batteries with instrumented squibs (matches) provided to the Air Force for F-15 compatibility tests
- ABNORMAL = TDs not considered missile flightworthy
- ENG = TDs used by NWC for engineering tests and evaluation
- EMV/HERO = Electromagnetic vulnerability and Hazards of Electromagnetic Radiation to Ordnance (HERO) qualification tests

TESTS CONDUCTED

ACCEPTANCE TESTS

As shown in Figures 1 and 2, each of the original 52 prototype TDs, plus 32 reworked TDs, were subjected to room temperature acceptance testing. Forty-nine of the original TDs and 28 reworked TDs were subjected to high- and low-temperature acceptance testing. These tests checked each of the TD operating requirements specified by the contract. The high- and low-temperature acceptance tests were made at +62 ± 2°C and

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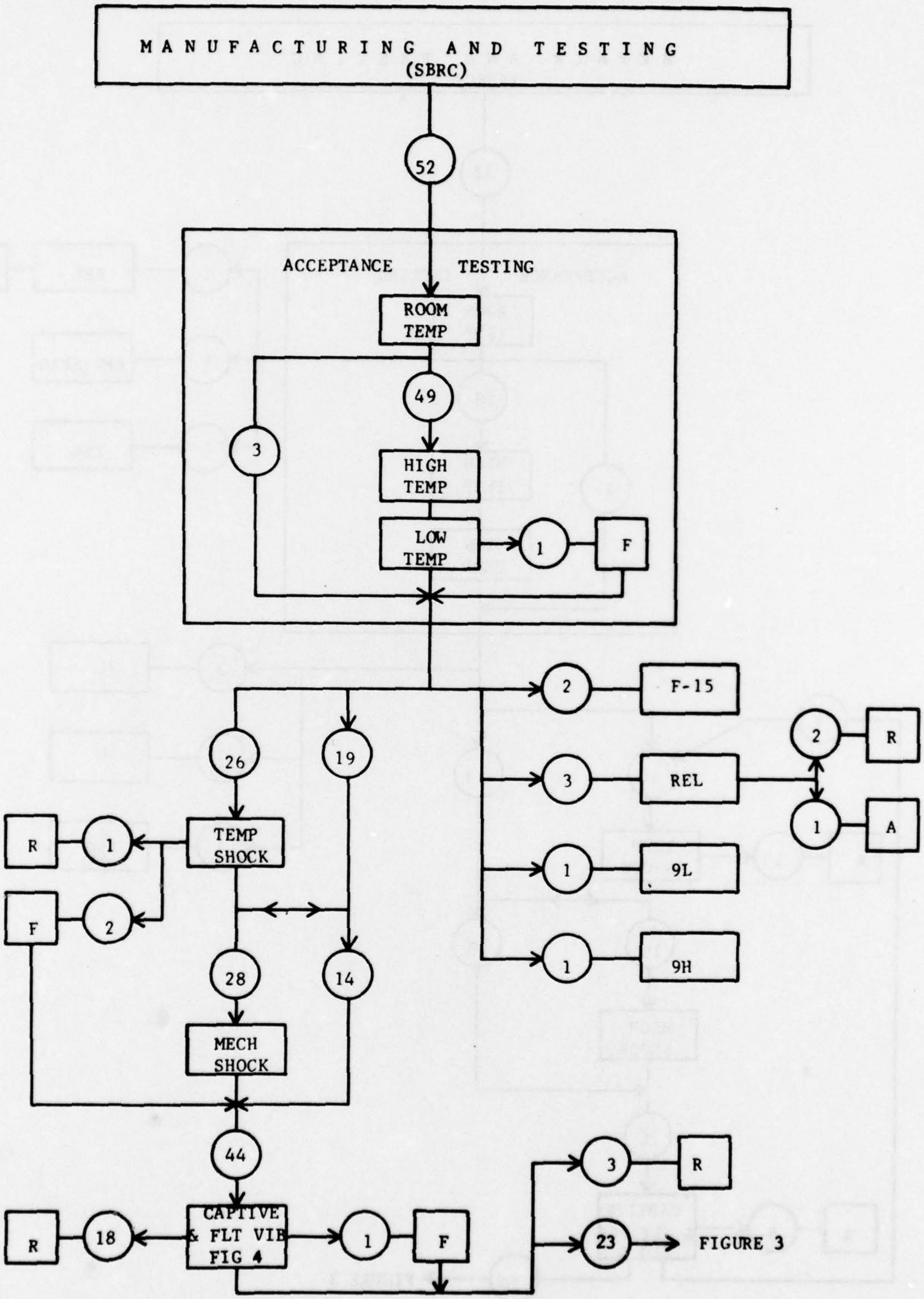

FIGURE 1. Room Temperature Acceptance Test Sequence.

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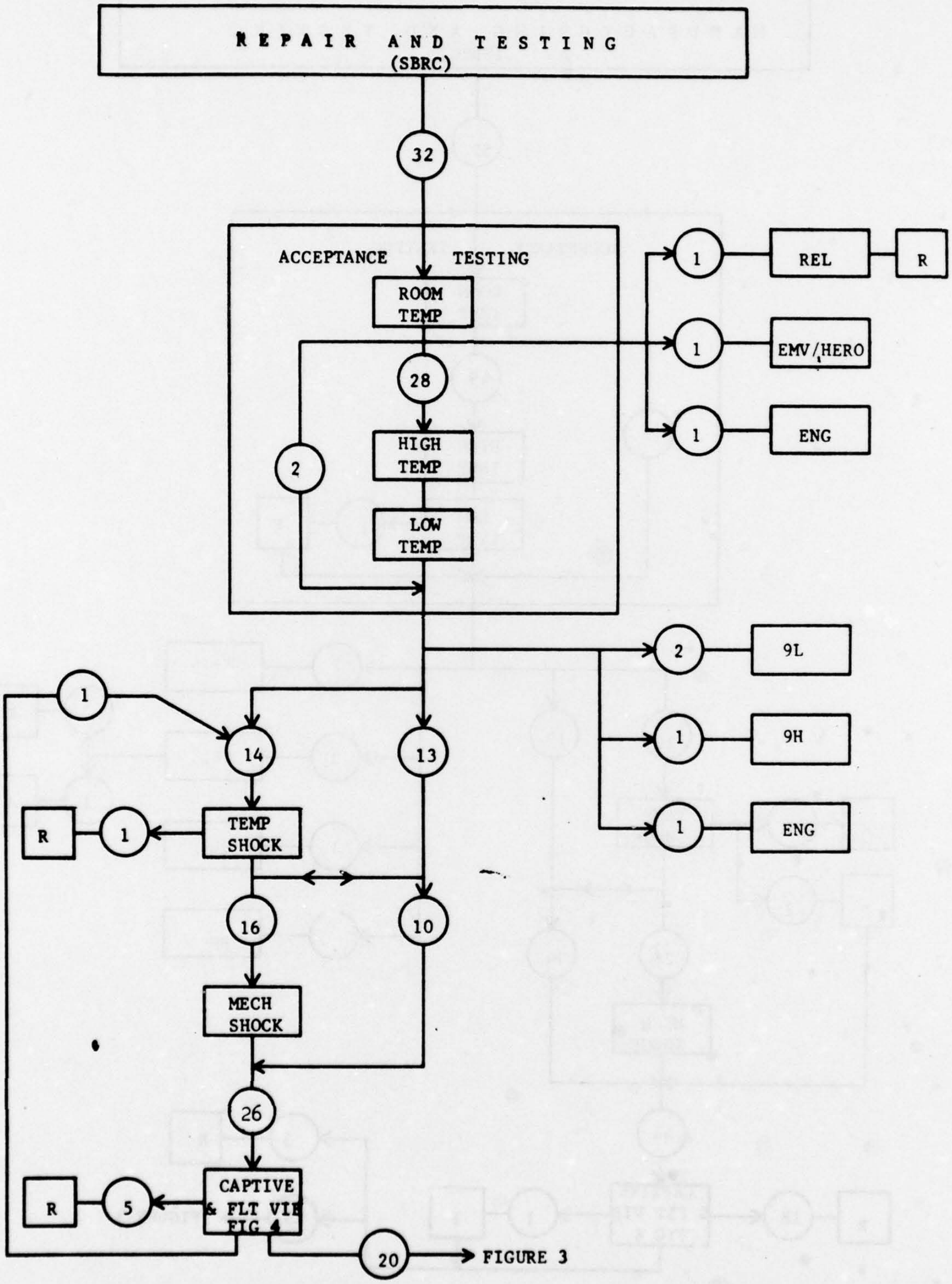

FIGURE 2. Room Temperature Acceptance Test Sequence (After Repair and Testing by SBRC).

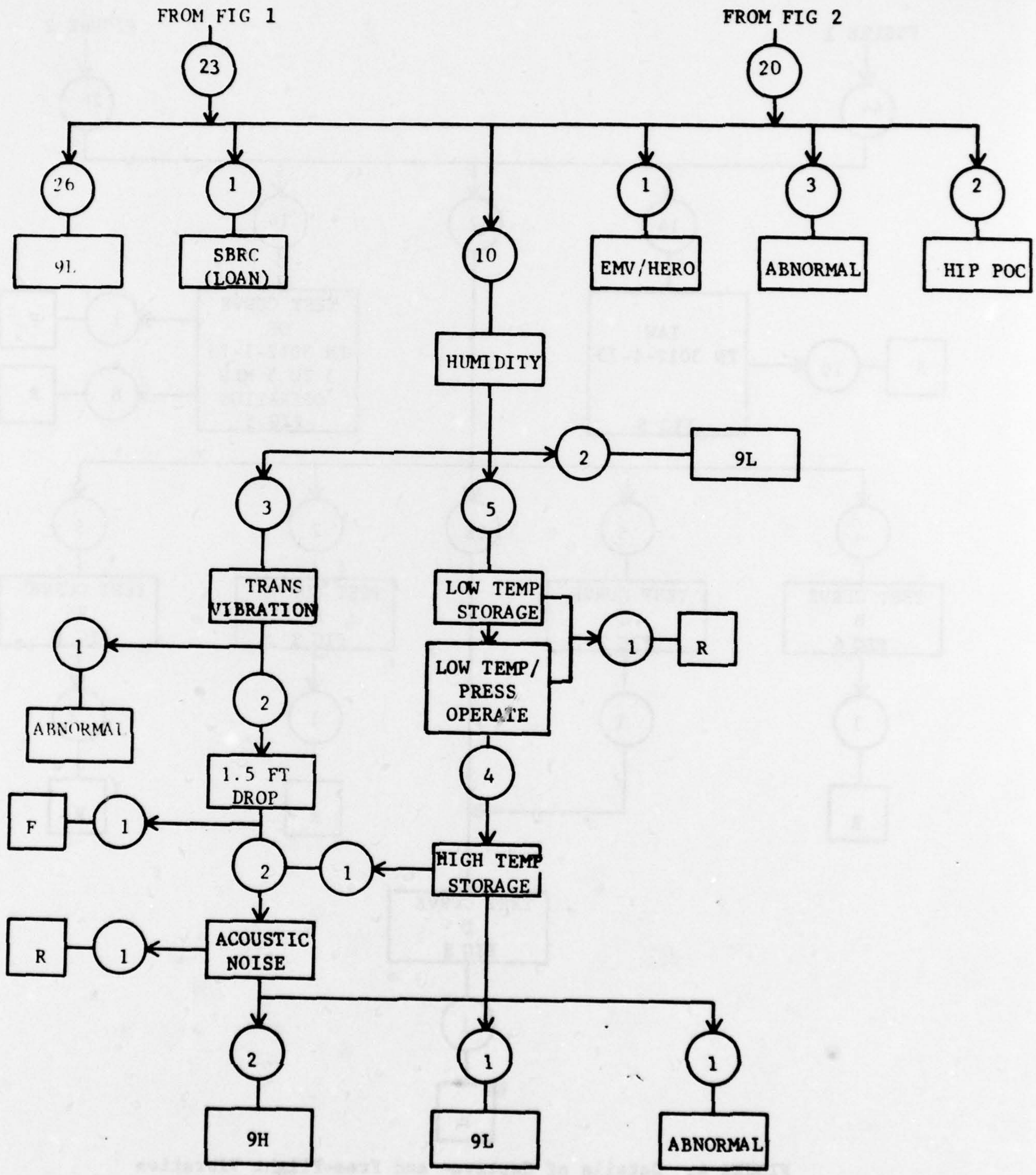

FIGURE 3. Room Temperature Acceptance Test Sequence (Continuation of Figure 1 and Figure 2).

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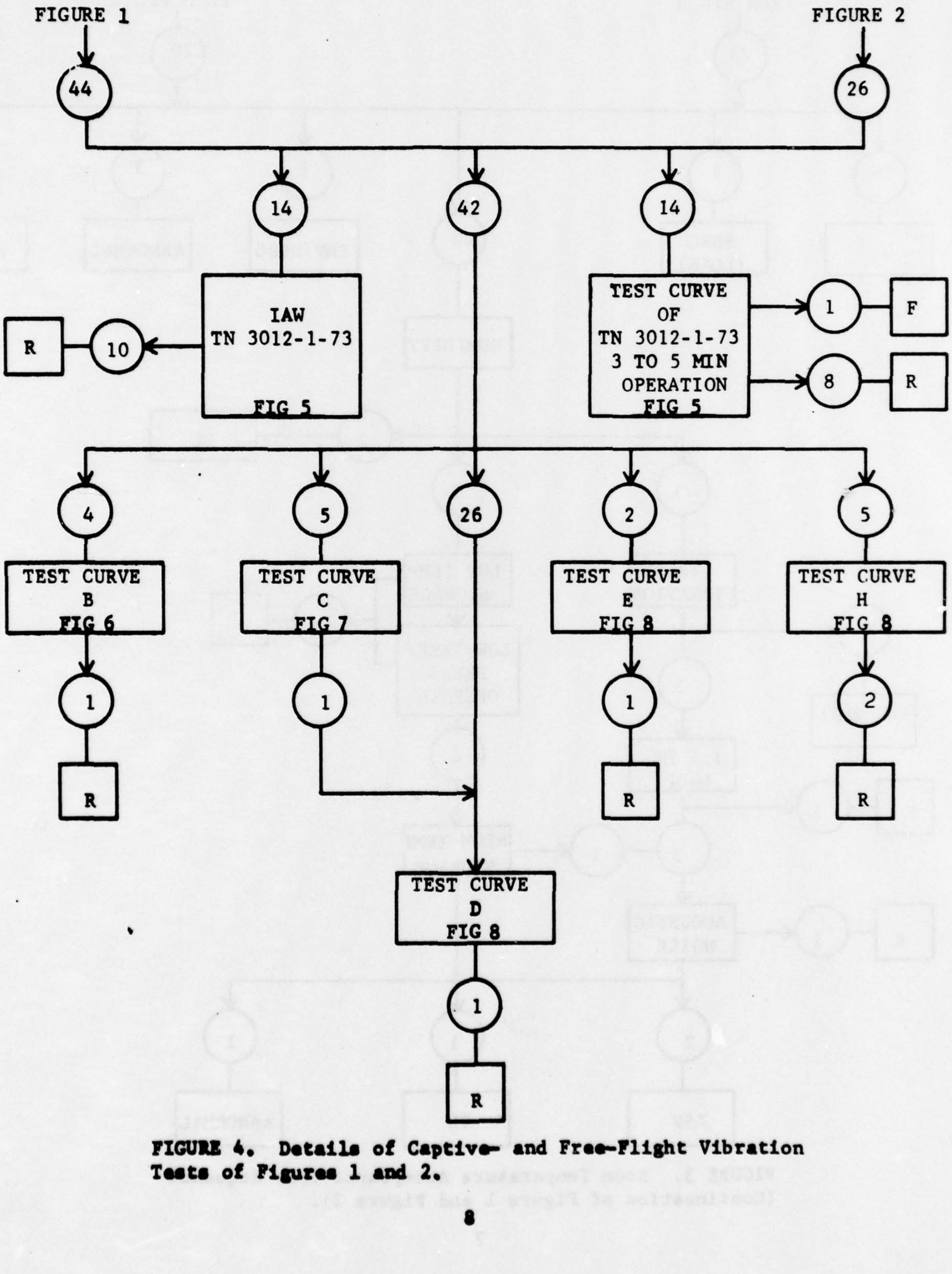

FIGURE 4. Details of Captive- and Free-Flight Vibration Tests of Figures 1 and 2.

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$-52 \pm 2°C$, respectively. Twelve failures were detected during acceptance testing. These failures are identified in Table 1, along with the corrective action taken. The TDs with the condensation problem were judged to be flightworthy; therefore, they were not repaired.

TABLE 1. Acceptance Test Failures and Corrective Action Taken.

TD serial no.	Failure	Corrective action
301 302 303 305 307 313 316 317	Condensation appearing on internal window surfaces and optics at -52°C.	Increased vacuum bake time of final assembly.
322	Solder splash, shorting pin P of connector J3 to ground.	Tighten inspection procedures.
332	Missile indexing pins misaligned.	None; assembly/inspection error.
338	High-intensity background caused increased false alarm rate and firing.	Redesign detector bias circuitry.

TEMPERATURE SHOCK TESTS

Twenty-six of the 52 original TDs and 14 reworked TDs were subjected to temperature shock. Three failures occurred and are identified in Table 2, along with the corrective action taken.

TABLE 2. Temperature Shock Test Failures and Corrective Action Taken.

TD serial no.	Failure	Corrective action
304	Voltage regulator MC1553 filled with potting compound.	None. Defective header seal; random component failure.
305	Resistor RWR8052491FM: broken lead at body lead/body interface.	Reduce thickness of conformal coating.
307	Resistor RCR05G331JM body cracked.	Reduce thickness of conformal coating.

MECHANICAL SHOCK TEST

Appendix B specifies that the shock pulse shall be sawtooth in shape. A sawtooth shape was utilized on a few of the TDs tested; however, to expedite testing, a half-sine wave shape of the same amplitude was utilized for most of the testing, by request of the NWC environmental laboratory. Twenty-eight of the 52 original TDs and 16 of the reworked TDs were subjected to mechanical shock. No TD failures occurred during this test.

VIBRATION TESTS

The vibration tests were by far the most successful in identifying mechanical defects within the TD. Forty-four of the original 52 TDs and 26 of the reworked TDs were subjected to captive- and free-flight vibration testing (see Figure 4). As it became apparent that prototype design deficiencies existed (see Table 3), deviations from the test plan were made. For example, special engineering evaluation sinusoidal sweep tests were performed on 12 TDs. When it was believed that all of the mechanical deficiencies had been identified and corrective measures developed, abbreviated vibration schedules were utilized to avoid repetitive failures that would unnecessarily increase program costs and adversely affect TD hardware availability for the flight test program. In addition, as preliminary instrumented captive-flight test data were gathered, it became apparent that the gravity unit (g) levels used in testing should be reduced; consequently, the authenticated version of AS-2718 specified 0.01 g^2/Hz maximum for the TD.

Test Curve of TN 3012-1-73

Eleven of the 52 original TDs and three reworked TDs were subjected to vibration testing exactly as specified in TN 3012-1-73 (30 minutes per axis, with the TD powered two minutes on, then two minutes off). Eleven of the original TDs and three reworked TDs were subjected to the test curve of TN 3012-1-73, but the total vibration table excitation time and TD power on time was from 3 to 5 minutes. The test curve of TN 3012-1-73 is shown in Figure 5. In many cases, the special sine sweep tests mentioned previously were run intermixed with the random vibration tests of TN 3012-1-73. Three TDs failed during the sine sweep cycle (see Appendix A). The failures resulting from the test curve of TN 3012-1-73 and sine sweep are tabulated in Table 3, Column 1. The notation (SS) indicates the failures that occurred during sine sweep.

Testing Using Other Test Curves

The vibration table excitation times and the TD power on time per axis for the five other test curves are tabulated as follows (see Appendix

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TABLE 3. Vibration Test Failures and Corrective Action Taken.

TD Serial No.		Failure	Corrective action
Curve per TN 3012-1-73	Other curves		
301 305 306 307 309 310 313 317	 317 336 343	Voltage regulator MC1569R; Catastrophic: loose particles in case of MC1569R shorted circuitry.	Redesign power supply using discrete transistor circuit.
302		Broken transistor lead on DC/DC board.	Stiffen and damp DC/DC
302		Broken resistor lead on preamplifier board.	None; random failure.
304		Rotated transmitter lens.	Add A-12 (Armstrong bonding) to all lenses.
304(SS)		Broken wire to source board.	Spot bond wiring.
307(SS)		Broken lead on transistor Q4 of source board.	Stiffen and damp source board.
315(SS)		Collector-emitter short in transistor Q4 of source board.	Random failure of JAN TX 2N5666.
320		Receivers and leads moving, causing noise.	Spot bond receivers and leads.
329		High false-alarm rate.	Not returned for repair.
330		Broken lead on thermistor (source board).	Spot bond thermistor.
331 332	323	Broken leads on source transformer.	Stiffen and damp source board. Bond transformer to board.
	325	Receiver diode excess leakage: Probably lead touching chip.	Impose additional lead dress requirements on vendor.

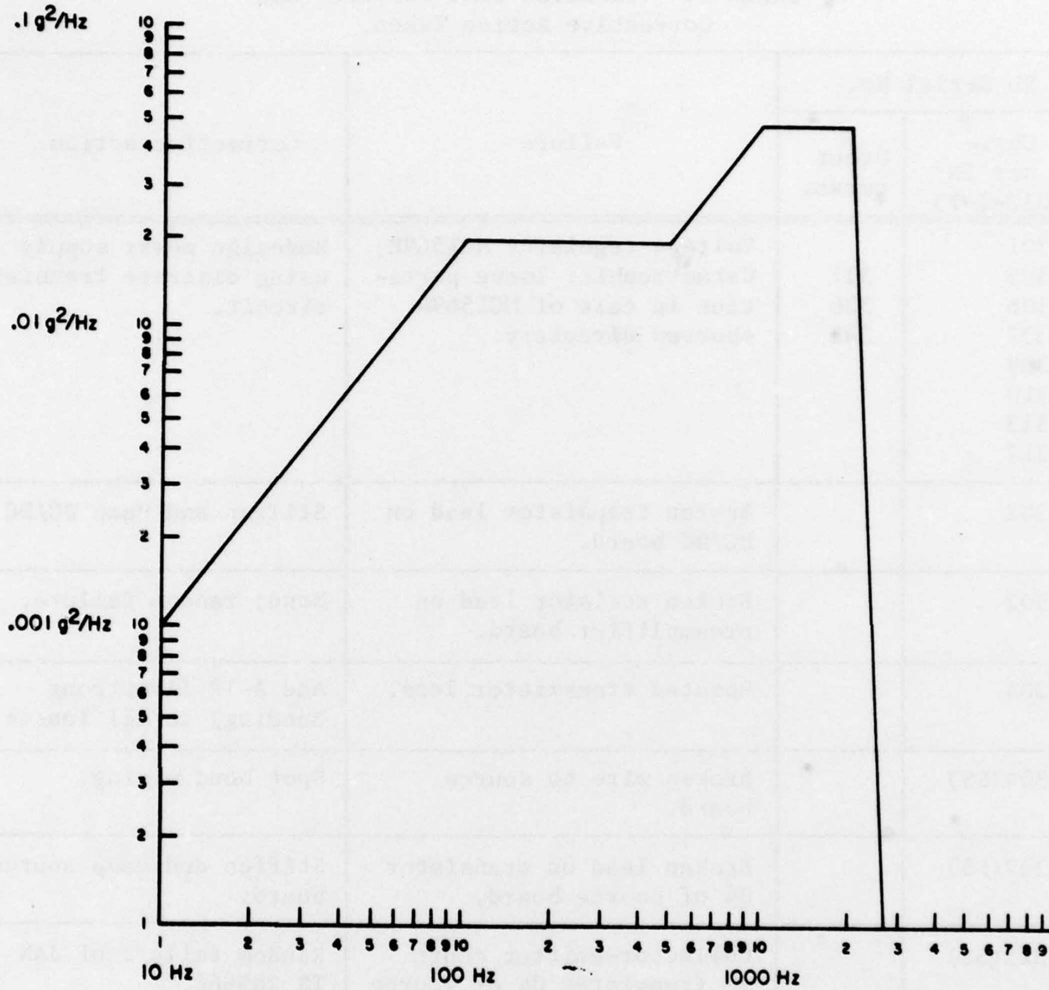

FIGURE 5. Power Spectral Density, Curve A, 9.1 g rms. (Test Curve of TN 3012-1-73).

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B (Figure 4) for major axes designation):

1. Curve B (Figure 6): 30 minutes of excitation per axis, TD powered 3 minutes per axis

2. Curve C (Figure 7): 5 minutes of excitation per axis, TD powered 5 minutes per axis

3. Curve D (Figure 8): 5 minutes of excitation per axis, TD powered 5 minutes in the X and Z axis and 1 minute in the Y axis

4. Curve E (Figure 8): 5 minutes of excitation per axis, TD powered 5 minutes per axis

5. Curve H (Figure 8): 5 minutes of excitation per axis, TD powered 5 minutes per axis

A one-minute TD operating time in the Y axis of Curve D was used to prevent additional MC1569R voltage regulator failure. The failure problem had been identified (see Table 3), but correction was not practical at that time. Twenty-two of the original 52 TDs and 20 reworked TDs were subjected to the five other test curves. The failures resulting from these tests are tabulated in Table 3, Column 2.

HUMIDITY TESTS

As shown in Figure 3, a total of 10 TDs were subjected to humidity tests in accordance with TN 3012-1-73. This test called for a 14-day cycling. The authenticated version of AS-2718 only requires a 4-day cycling of a similar test. No TD failures occurred during this test.

LOW-TEMPERATURE STORAGE AND LOW-PRESSURE/LOW-TEMPERATURE OPERATE TESTS

Five TDs were subjected to these tests in accordance with TN 3012-1-73. One failure occurred (Table 4). It is not known which test was failed by the TD, because no operability test was run after low-temperature storage.

TABLE 4. Low-Temperature Storage and Low-Pressure/Low-Temperature Operate Test Failures and Corrective Action Taken.

TD serial no.	Failure	Corrective action
305	Receiver diode leads touching clip.	Impose additional lead dress requirements on vendor.

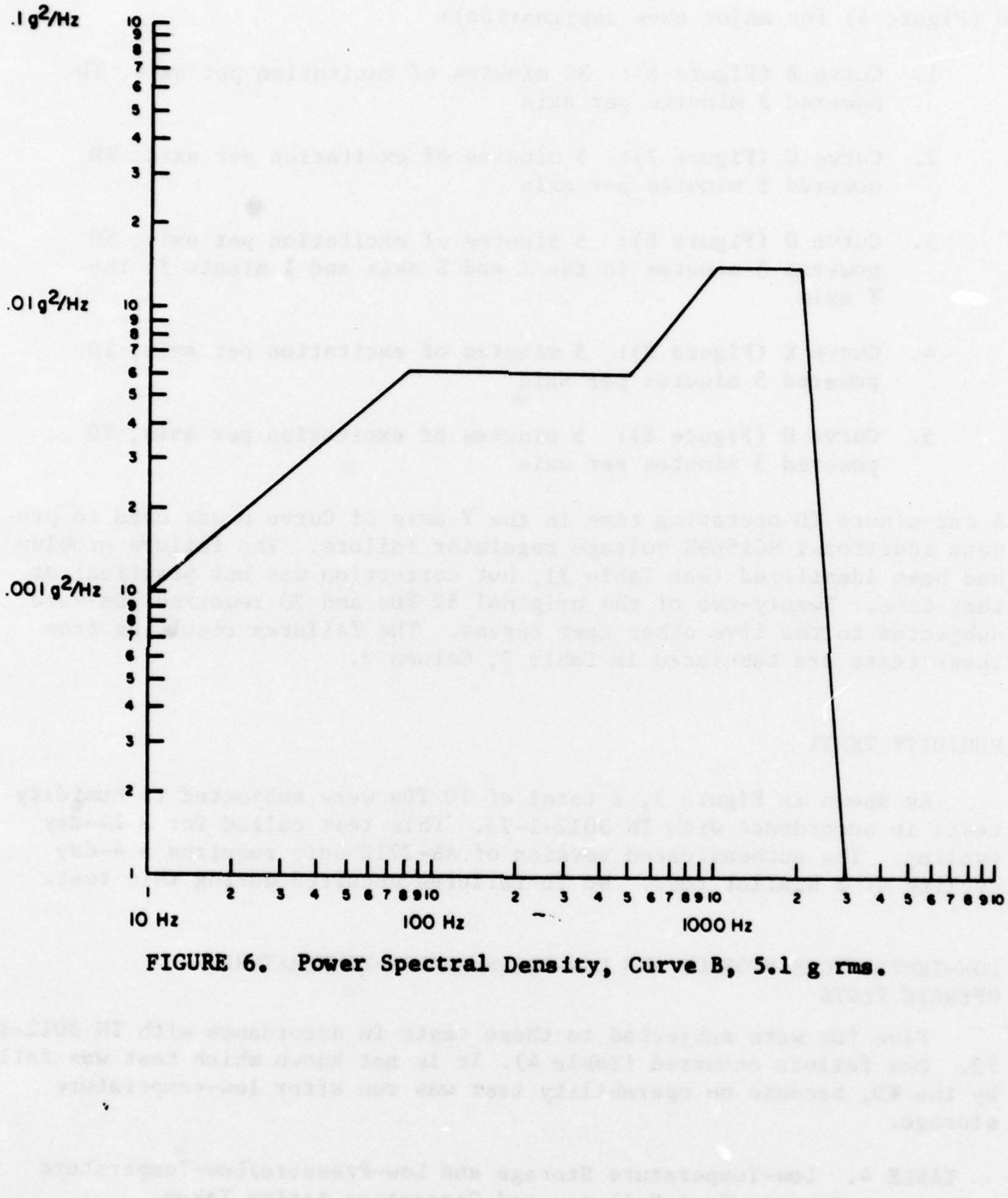

FIGURE 6. Power Spectral Density, Curve B, 5.1 g rms.

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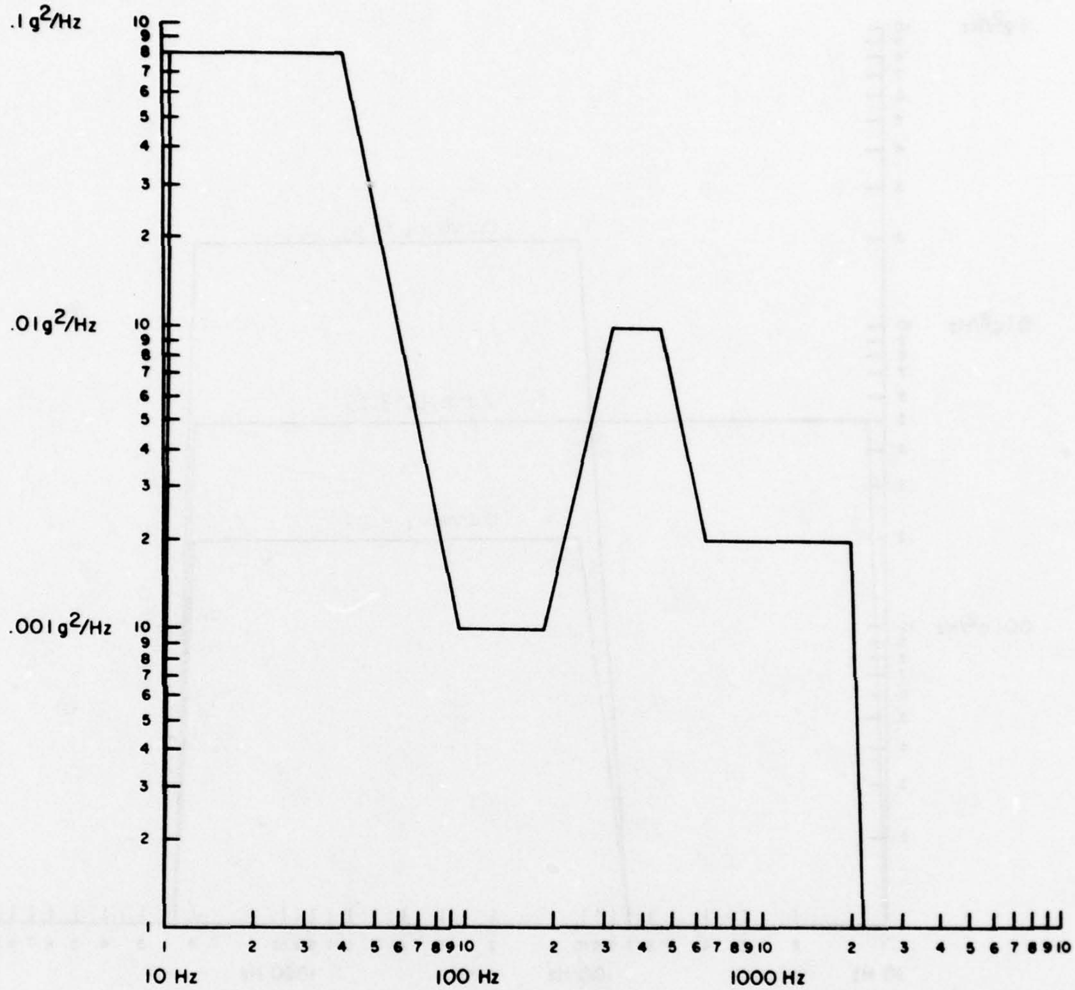

FIGURE 7. Power Spectral Density, Curve C, 3.4 g rms.

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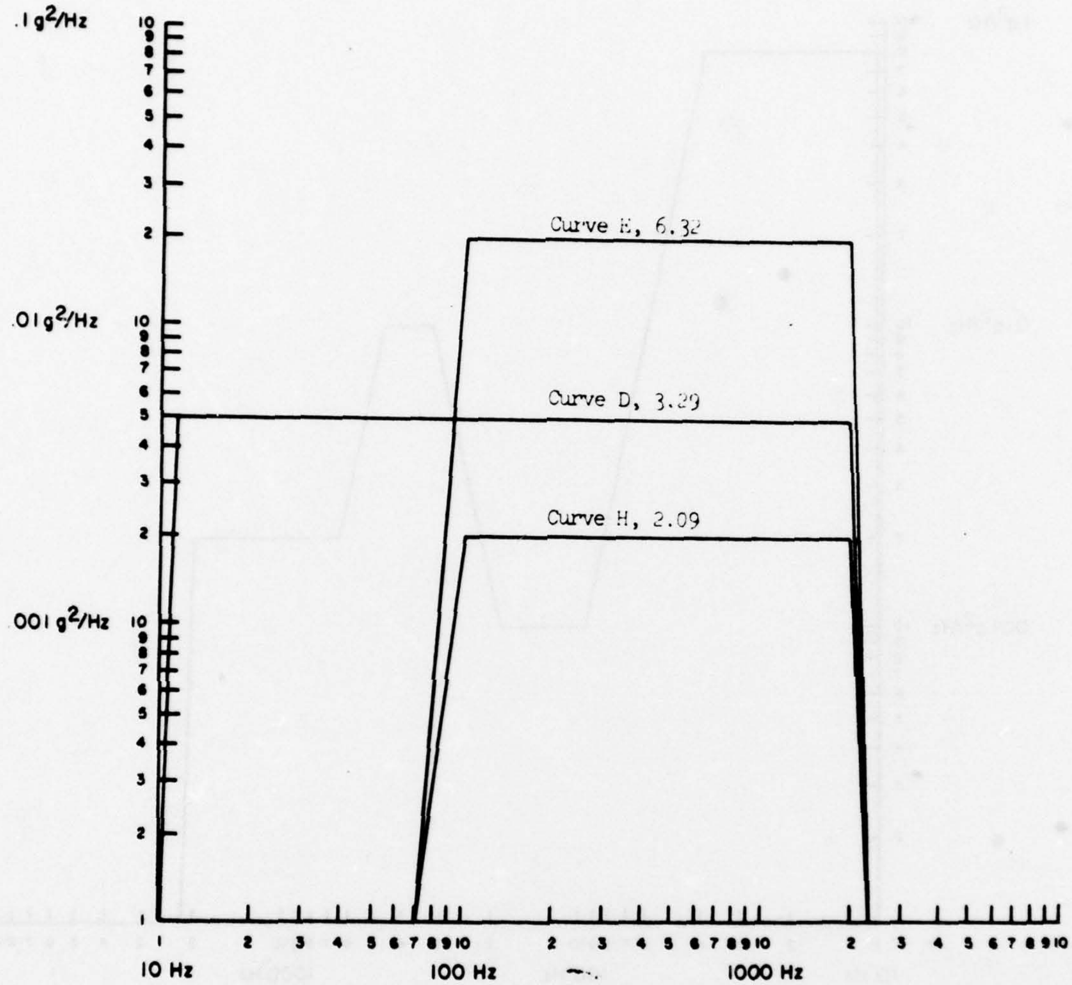

FIGURE 8. Power Spectral Density, Curves D, E, and H.

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HIGH-TEMPERATURE STORAGE TESTS

Four TDs were subjected to high-temperature storage tests in accordance with TN 3012-1-73. No TD failures occurred.

TRANSPORTATION VIBRATION TESTS

Three TDs were subjected to transportation vibration tests in accordance with TN 3012-1-73. No failures occurred.

DROP TEST (1.5-FOOT)

Two TDs were subjected to the 1.5-foot drop test in accordance with TN 3012-1-73. One failure occurred, as shown in Table 5.

TABLE 5. Drop-Test Failure and Corrective Action Taken.

TD serial no.	Failure	Corrective action
327	No B+ (165V) reference voltage.	None. Not returned to manufacturer for repair.

ACOUSTIC NOISE TEST

Two TDs were subjected to an acoustic noise test. The TD was powered during the test chamber acoustic excitation time of 10 minutes. Each TD was subjected to the two acoustic spectrums shown in Figures 9 and 10. One failure occurred, as shown in Table 6.

TABLE 6. Acoustic Noise Failure and Corrective Action Taken.

TD serial no.	Failure	Corrective action
321	Ceramic capacitor, C2 on preamp module microphonic.	Change C2 to glass capacitor on all phase three units.

MISCELLANEOUS

Some failures occurred during the environmental test program that do not fit into the format presented in this report.

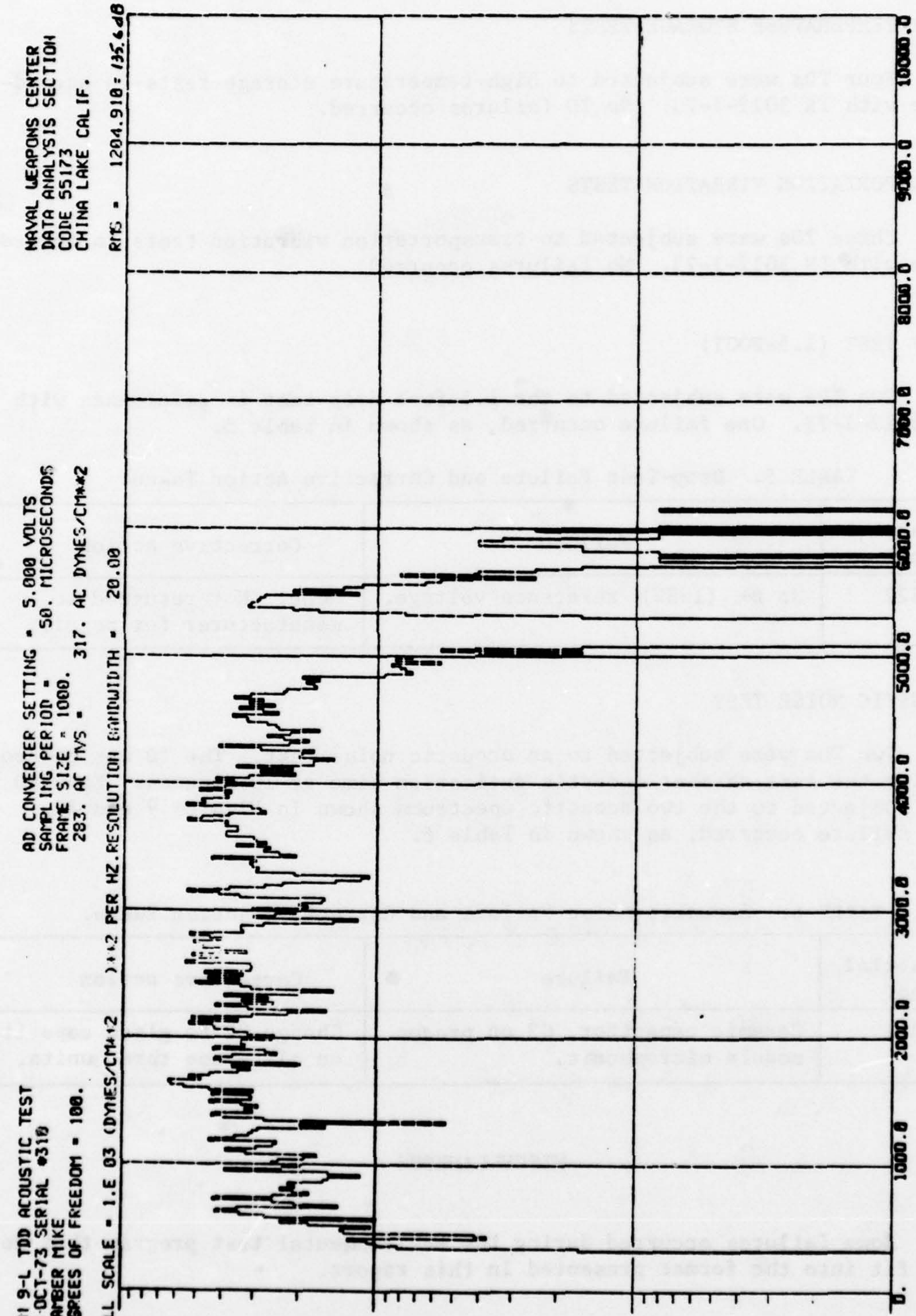

FIGURE 9. Power Spectral Density.

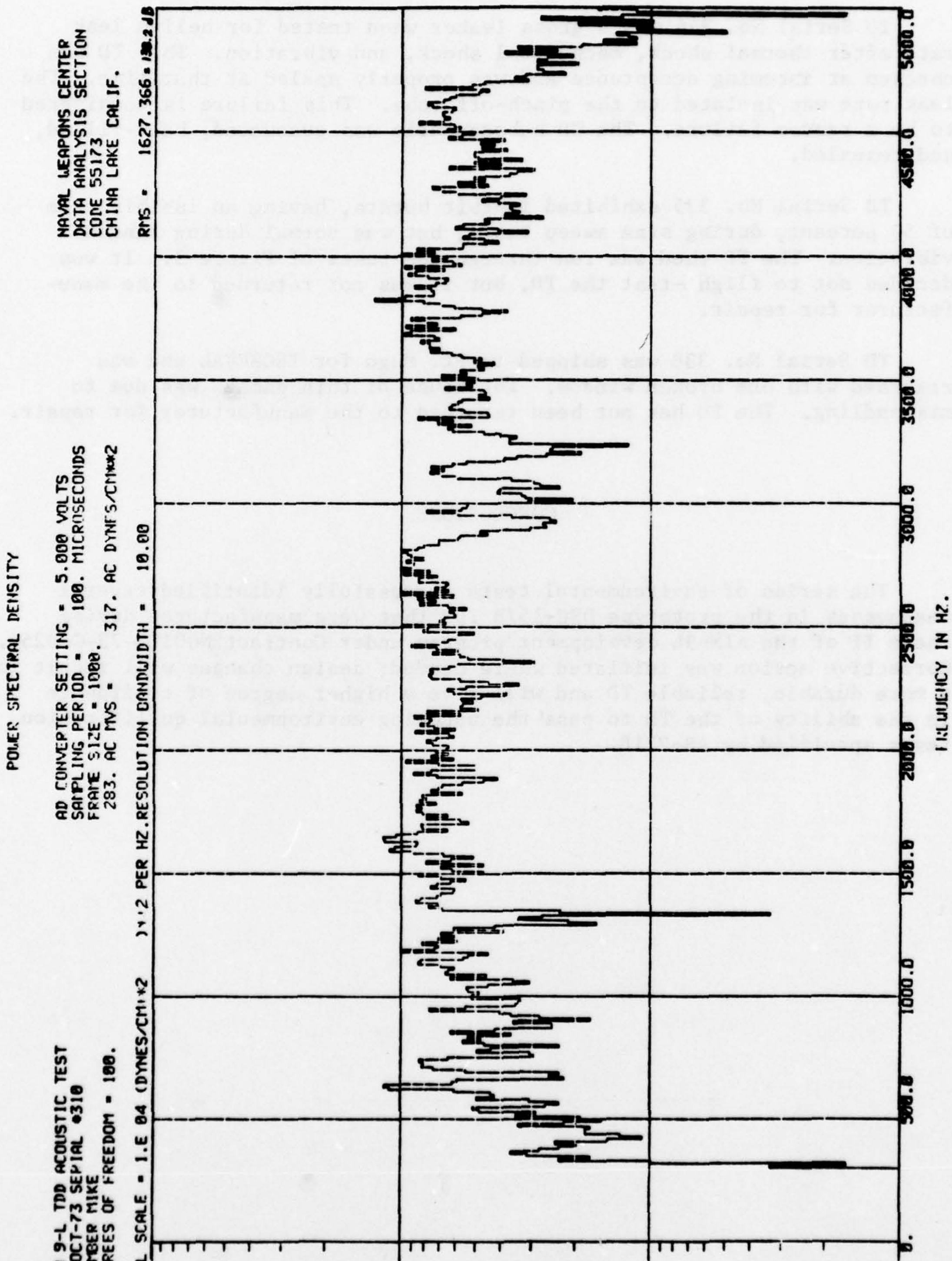

FIGURE 10. Power Spectral Density.

TD Serial No. 344 was a gross leaker when tested for helium leak rate after thermal shock, mechanical shock, and vibration. This TD was checked at incoming acceptance and was properly sealed at that time. The leak rate was isolated to the pinch-off tube. This failure is considered to be a random failure. The TD subsequently was evacuated, back-filled, and resealed.

TD Serial No. 335 exhibited inhibit bursts, having an inhibit rate of 50 percent, during sine sweep tests, but was normal during random vibration. The TD then was run through the tests of Figure 3. It was decided not to flight-test the TD, but it was not returned to the manufacturer for repair.

TD Serial No. 338 was shipped to Pt. Mugu for TECHEVAL and was returned with one broken window. The cause of this damage was due to mishandling. The TD has not been returned to the manufacturer for repair.

CONCLUSIONS

The series of environmental tests successfully identified several weaknesses in the prototype DSU-15/B TDs that were manufactured during Phase II of the AIM-9L development program under Contract N00123-73-C-0256. Corrective action was initiated where needed; design changes will result in a more durable, reliable TD and will give a higher degree of confidence in the ability of the TD to pass the upcoming environmental qualification tests specified by AS-2718.

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Appendix A

ENVIRONMENTAL TEST RESULTS OF VARIOUS DSU-15/B TARGET DETECTORS

Test results and the disposition of DSU-15/B TDs (Serial No. 301 through 352) are shown in Tables A-1 and A-2. Table A-1 shows the tests covered by Figures 1 and 2 herein. Table A-2 shows the tests covered by Figure 3 herein.

The test results are indicated in the tables by means of code letters, which are defined as follows:

Code letter	Meaning
P	Indicates that the TD operated normally during the test and met all specifications required by the contract
F	Indicates a minor out-of-specification condition during the test; the missile system performance was considered not measurably degraded
M	Indicates a major out-of-specification condition; the TD could degrade the missile system performance significantly
C	Indicates that the TD was inoperable after the test or that the missile system using the TD would be inoperable

The first horizontal line of letters (to the right of the TD serial number in the tables) shows the test sequence to which the TD was originally subjected; each additional horizontal line after a TD serial number indicates that the TD failed that test, was reworked and submitted to the next test sequence.

Blank spaces in the tables indicate that the TD was not subjected to the test during that sequence.

The test curve column in Table A-1 indicates the vibration spectrum that was used for that sequence, and is defined as follows:

Code	Meaning
A1	Indicates vibration in accordance with TN 3012-1-73 (see Figure 5 in text of this document)
A2	Indicates vibration to spectrum of TN 3012-1-73, except for short duration (see Figure 5 in text of this document)
B, C, D, E, and H	Explained in text of this document (see Figures 6, 7, and 8)

The sine sweep column in Table A-1 indicates which TDs were subjected to the special sinusoidal sweep tests mentioned in the text. The referenced code letters indicate the test curve to which the TDs were subjected, as follows:

Code	Meaning
F	10 gravity units (*g*), peak
G	7 *g*, peak

The sweep was logarithmic from 0.5 to 5 kHz for 2 1/2 minutes and then from 5 to 0.5 kHz for a second 2 1/2 minutes, for a total duration of 5 minutes vibration.

The disposition column in the tables indicates what was done with each TD after completion of the test sequence.

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TABLE A-1. Environmental Test Summary.[a]

TD SERIAL NUMBER	ROOM TEMP ACCEPTANCE	LOW TEMP. OPERATE	HIGH TEMP. OPERATE	THERMAL SHOCK	MECHANICAL SHOCK	RANDOM VIBRATION	TEST CURVE	SINE SWEEP	DISPOSITION
301	F	M	F	P	P	C	A1		REPAIRED
	P	F	F	P	P	P	A1		SEE TABLE A-2
302	F	M	F		P	.C	A1		REPAIRED
	F	M	F	P	P	C	A1		REPAIRED
	F	F	P	P	P	P	D		-9L FLIGHT
303	P	M	P	P	P	P	A1		ABNORMAL
304	F	F	F	M		C	A1		REPAIRED
	P	P	F	P	P	C	A2		REPAIRED
	P	P	P		P	P	D	F	-9L FLIGHT
305	P	M	F	C		P	A1		REPAIRED
	P	F	P	P	P	C	A1		REPAIRED
	P	F	P			P	C		SEE TABLE A-2
	P	F	P						AEROSOL TESTS
306	P	F	P		P	C	A1	G	REPAIRED
	P	P	P	P	P	P	D		-9L FLIGHT
307	P	M	P	P	P	C	A1		REPAIRED
	P	P	P	P	P	C	A2	F	REPAIRED
	P			M		P	D		REPAIRED
	P	P	F						-9H FLIGHT
308	F					P	A1		HIP-POCKET FLIGHT
309	P	P	P	P	P	C	A1		REPAIRED
	P	P	P			P	A2	G	SEE TABLE A-2
310	P	F	F	P	P	C	A1		REPAIRED
	P	P	P			P	D		-9L FLIGHT
311-S[b]	F	P	F						F-15 TESTS
312-S[b]	P	F	P						F-15 TESTS
313	P	M	P	P	P	C	A1		REPAIRED
	P	P	P		P	P	D		-9L FLIGHT
314	P					P	A2		HIP-POCKET FLIGHT

[a]See Figure 1 and 2 of this report.

[b]The suffix -S means special instrumented thermal battery.

TABLE A-1. (Contd.)

TD SERIAL NUMBER	ROOM TEMP. ACCEPTANCE	LOW TEMP. OPERATE	HIGH TEMP. OPERATE	THERMAL SHOCK	MECHANICAL SHOCK	RANDOM VIBRATION	TEST CURVE	SINE SWEEP	DISPOSITION
315	P P	P P	P P		P P	C P	A2 D	G	REPAIRED -9L FLIGHT
316	P	M	P	P	P	P	A2		SEE TABLE A-2
317	P P P	M P	P P	P P	P P	C C P	A1 H D		REPAIRED REPAIRED -9L FLIGHT
318	P	F	P	P	P	P	B		-9L FLIGHT
319	P	F	P	P	P	P	B		-9L FLIGHT
320	P P	F F	F P	P	P	M P	A2 H		REPAIRED -9L FLIGHT
321	P P	F F	P P	P	P	F	A2		SEE TABLE A-2 -9L FLIGHT
322	C P	F F	P P	P		 P	 D		REPAIRED -9L FLIGHT
323	P P	F F	P P	P	P	M P	B C		REPAIRED SEE TABLE A-2
324	P	P	P			P	C		-9L FLIGHT
325	P P	F P	P P	 P	 P	M P	C,D D		REPAIRED -9L FLIGHT
326	P	F	P	P	P	P	D		-9L FLIGHT
327	F	F	P	P	P	F	A2	F	SEE TABLE A-2
328	P	F	P	P	P	P	D		-9L FLIGHT
329	P	F	P	P.	P	M	A2	F	SEE TABLE A-2
330	P P	F P	P P	P	P	C P	A2 D	F	REPAIRED -9L FLIGHT
331	P P	F F	P P	P	P	C P	A2 D	F	REPAIRED -9L FLIGHT
332	P P	F F	F P	 P	 P	C P	A2 D	F	REPAIRED ABNORMAL

TABLE A-1. (Contd.)

TD SERIAL NUMBER	ROOM TEMP. ACCEPTANCE	LOW TEMP. OPERATE	HIGH TEMP. OPERATE	THERMAL SHOCK	MECHANICAL SHOCK	RANDOM VIBRATION	TEST CURVE	SINE SWEEP	DISPOSITION
333	P	P	P			P	D		-9L FLIGHT
334	P	P	P			P	D		-9L FLIGHT
335	P	F	P		P	P	E	G	SEE TABLE A-2
336	P P	F P	P P	 P	P P	C P	E D	G	REPAIRED ABNORMAL
337	P	F	F			P	H		-9L FLIGHT
338	P P	M F	F P	 P	 P	P P	C D		REPAIRED -9L FLIGHT
339	F	F	F			P	C		SEE TABLE A-2
340	P	P	P			P	D		-9L FLIGHT
341	P	F	P			P	H		-9L FLIGHT
342	P	P	P			P	D		-9L FLIGHT
343	P P	 P	 P	 P	 P	C P	H D		REPAIRED EMV/HERO TESTS
344	P P	F P	P P	← M SEE TEXT →			D		REPAIRED -9L FLIGHT
345	P	F	P	P	P	P	D		SBRC, Loan
346	P	P	F	P	P	P	D		-9L FLIGHT
347	F	F	F	P	P	P	D		-9L FLIGHT
348	P	P	F						-9H FLIGHT
349	P	P	P						-9L FLIGHT
350	P P	F	P						SEE TABLE A-2 EMV/HERO TESTS
351	P P P	P	F						SEE TABLE A-2 SEE TABLE A-2 ENG, NAVWPNSCEN
352	P	P	F						SEE TABLE A-2

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TABLE A-2. Environmental Test Summary.[a]

TD SERIAL NUMBER	HUMIDITY	LOW-TEMP. STORAGE	LOW-PRESS. OPERATE	HIGH-TEMP. STORAGE	RELIABILITY DEMONSTRATION	ENGINEERING TESTS	RELIABILITY	TRANSPORT VIBRATION	1.5-FOOT DROP	ACOUSTIC NOISE	DISPOSITION
301	P										-9L FLIGHT
305	P	←M→									REPAIRED
309	P	P	P	P						P	-9H FLIGHT
316	P										-9L FLIGHT
321	P							P	P	M	REPAIRED
323	P	P	P	P							-9H FLIGHT
327	P							P	M		ABNORMAL
329	P							P			ABNORMAL
335	P	P	P	P							ABNORMAL
339	P	P	P	P							-9L FLIGHT
350					C						REPAIRED
351					C C						REPAIRED REPAIRED
352					P						SBRC, ANALYSIS

[a]See Figure 3 of this report.

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TN 3012-1-73
15 January 1973

QUALIFICATION TEST PLAN
FOR
TARGET DETECTOR
DSU-15(XCR-2)/B

TECHNICAL MANAGEMENT OFFICE
CODE 3012

NAVAL WEAPONS CENTER

China Lake, California 93555

30

TN 3012-1-73

15 January 1973

QUALIFICATION TEST PLAN

FOR TARGET DETECTOR

DSU-15(XCR-2)/B

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QUALIFICATION TEST PLAN FOR
TARGET DETECTOR DSU-15(XCR-2)/B

1. SCOPE

1.1 Purpose

The prototype qualification test program is performed to (1) qualify the design, (2) obtain performance data under simulated service conditions, and (3) provide for an assessment of the functional capabilities of target detector DSU-15(XCR-2)/B.

1.2 Application

This document covers the laboratory qualification, engineering test, and reliability program for target detector (TD) devices fabricated for the prototype design phase of the AIM-9L missile development program.

2. GENERAL REQUIREMENTS

2.1 Target Detector

The TD is an active optical (AO) influence device designed to transmit optical energy and to initiate a firing signal by receiving reflected optical energy from a proximate target. It is 7 inches long, 5 inches in diameter, and weighs 9 pounds.

2.2 Test Equipment

Appropriate equipment shall be used for environmental and acceptance testing as specified in paragraphs 2.2.1 and 2.2.2.

2.2.1 Environmental Tests. The equipment shall be capable of providing the vibration spectrum, shock envelopes, pressure, temperatures, and environmental conditions required to meet standards and/or specifications as directed. During all environmental tests, the TD shall be secured to devices that simulate the mating missile sections.

2.2.2 Acceptance Test Set. The acceptance test set shall be used to test the TD to the requirements of the test specifications. The set consists of a monitor and control console, a temperature chamber, an indexable mounting fixture, and a range/target track. Requirements for the test set are contained in XAS-3230.

2.3 Test Sequence

The sequence of testing shall be in accordance with Fig. 1, 2, and 3.* However, the engineering tests listed in Fig. 2 are for information only. They are not an integral part of the TD qualification test plan. The detailed test procedures shall be in accordance with paragraph 3 of this document, supplemented by military standards where referenced.

2.4 Applicable Documents

1.	MIL-STD-331	Fuze and Fuze Components, Environmental and Performance Test for
2.	MIL-STD-810	Environmental Test Methods
3.	TN 3012-1-72	Environmental/Safety Qualification Test Plan for AIM-9L Missile
4.	XAS-2993	Warhead Group Development Specification
5.	XAS-2718	Environmental Design Criteria for Sidewinder AIM-9L Missile System
6.	XAS-2262	Military Specification Detector, Target DSU-15(XCR-2)/B
7.	XAS-3230	Acceptance Test Set, Target Detector DSU-15(XCR-2)/B
8.	TN 3012-10-72	Failure Reporting and Analysis Requirements AIM-9L Program
9.	XAS-2715	Air Specification Guided Missile System Air Intercept Sidewinder AIM-9L
10.	SK 639AS144	NWC Interface Schematic AIM-9L-TDD
11.	DL 597AS210	Fixture, Test, Vibration, Cube
12.	SK 639AS102	Correlation Drawing, AIM-9L Missile, Electrical
13.	X639AS845	TD Protective Cover

*Figures referenced in this document appear at the end of the report beginning on page 16.

2.5 Disposition of Defective TD

Any TD whose mechanical damage or defects constitute an operability failure at any point in the test sequence shall be removed from its specific test and examined to determine the cause of failure. Further routing of the TD to its assigned sequence shall be made dependent upon the type and cause of failure. A complete record shall be kept of any discrepancies, and a failure report shall be forwarded in accordance with TN 3012-10-72.

2.6 Measurements

All measurements shall be made with instruments which, unless otherwise specified, shall be capable of maintaining random test errors to less than 10% of the tolerance of the parameter to be measured. The maximum allowable measurement tolerance on test conditions (exclusive of the accuracy of the instruments) shall be as follows:

1.	Temperature	±3.6°F (2°C)
2.	Altitude	±1,000 ft
3.	Relative humidity	±5%
4.	Vibration amplitude	±10%
5.	Vibration frequency	±3%
6.	Acceleration	±5%
7.	Shock	±10%
8.	Input voltage	±3%
9.	Random vibration	±3 dB

2.7 Definitions

2.7.1 Operable. The ability of the TD to meet the requirements of the operability test, paragraph 3.4.

2.7.2 Three Major Axes. The three mutually perpendicular axes of the TD are shown in Fig. 4.

2.7.3 Forward Direction. The TD shall be mounted so that the 9-pin connector (J-5, SK 639AS102) is in the forward direction (see Fig. 4).

2.7.4 Quadrants. The TD is divided into four optical quadrants, which are consecutively numbered 1 through 4 as shown in Fig. 4.

2.8 Operating Test Recordings

1. Oscillograph recordings shall be made of functional parameters of the TD before, during, and after environments in which the TD is tested while it is energized.

2. The equipment for these tests shall include a DC power supply, a voltmeter, an ammeter, a recording oscillograph, and signal conditioning amplifiers.

3. The TD shall be powered and instrumented through the 26-pin test connector (J-3, SK 639AS102) at the aft end of the TD, and the following functions shall be recorded:

a. +28 volt power . . . . Pin X

b. +5 volt (low voltage converter) . . . Pin U

c. Fire pulse TM . . . . Pin T

d. Threshold. . . . . Pin C

e. Inhibit. . . . . Pin F

4. The TD shall be installed in the environmental test facility, and a pre-environmental test recording shall be made of the activation and deactivation of the functions.

5. The optics of the TD shall be masked, and the recording shall be repeated.

6. The functional parameters shall be recording during the environmental exposure to monitor the TD for spurious firings.

7. The recordings of steps 4 and 5 shall be repeated for a post-environmental satisfactory performance check.

2.9 Criteria for Qualification

1. The TD shall remain operable following any environmental exposure in which the TD was tested in the de-energized condition.

2. The TD shall remain operable (with no spurious firing) during and following any environmental exposure in which the TD was tested in the energized condition.

3. There shall be no physical deterioration of the TD as a result of any environmental exposure that interferes with normal TD operation.

3. DETAILED TEST PROCEDURE

3.1 Visual Inspection

1. The TD shall have no obvious damage or defect that might affect operability.

2. During incoming inspection and following all environmental tests, all external surfaces of the TD shall be visually inspected for damage or defects that may affect operability.

3. The weight of each TD shall be measured and recorded.

3.2 Radiographic Inspection

If operability or visual inspection shows degradation of TD, the TD may be examined internally by radiographic techniques to aid analysis.

3.3 Leak Inspection

1. Each TD is evacuated and filled at the factory to a positive pressure of 15 ±2 psig with gas consisting of $7\frac{1}{2} \pm 2\frac{1}{2}\%$ helium by volume, with the remainder being dry nitrogen.

2. The procedure shall be determined by the equipment used.

3. The helium gas leakage shall not exceed 1×10^{-6} cc/sec.

3.4 Operability Tests

TD operability tests shall be conducted as shown in Fig. 1, 2, and 3. The objectives of these tests are the same as those defined in XAS-2262.

3.4.1 Test Equipment. The operability tests shall be made with an approved test set or test setup as defined in XAS-2262.

3.4.2 Criteria for Passing Test. All test parameters shall have values between those limits specified in XAS-2262.

3.5 Temperature Shock

1. The TD shall not be energized during this exercise.

2. The TD shall be placed in a chamber that has been prestabilized at a temperature of 74 ±2°C. The TD shall be maintained at this temperature for not less than 2 hours.

3. The TD shall be transferred within 5 minutes to a cold chamber whose internal temperature is -52 ±2°C. The chamber shall be maintained at this temperature for not less than 2 hours.

4. The TD shall be returned to the high temperature chamber within 5 minutes after removal from the low temperature chamber.

5. Steps 2, 3, and 4 constitute one cycle of temperature shock. The TD shall be subjected to five cycles. At the conclusion of the final 2-hour cooling period of step 3, the TD shall be removed from the test chamber and returned to room ambient temperature.

6. The TD shall be examined for physical damage.

7. Operating test recordings shall be made in accordance with paragraph 2.8 after the TD has been stabilized at laboratory ambient temperature (16 to 27°C).

8. To be acceptable, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.6 Mechanical Shock

1. The test items shall be divided into three temperature groups.

2. The TD shall not be energized during the test.

3. The TD shall be subjected to 18 shocks (three in each direction along the three mutually perpendicular axes of the TD) in accordance with MIL-STD-810B, Method 516, Procedure I. Each shock pulse shall be sawtooth in shape with an amplitude of 20 g and a duration of 11 ms.

4. The shock test shall be performed with the TD temperature stabilized for not less than 1 hour at laboratory ambient temperature, at -40 ±2°C, and at +60 ±2°C.

5. The TD shall be examined for physical damage.

6. Operating test recordings shall be made in accordance with paragraph 2.8 after the TD has been stabilized at laboratory ambient temperature.

7. To be acceptable, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.7 Transportation Vibration

1. The TD shall be installed in a standard shipping container with all appropriate covers (four TDs are required). The TD shall not be energized.

2. The TD shall be tested in accordance with MIL-STD-810B, Method 514, Procedure X to the curve shown in Fig. 5. The vibration sweep shall be logarithmic 5-500-5 Hz in 15 minutes and be applied three times for a total of 45 minutes per axis for each of three temperatures.

3. The vibration shall be applied in each of the three orthogonal axes of the shipping container.

4. The vibration shall be applied with the shipping container and TD stabilized at room ambient temperature, at -30 ±2°C, and at +52 ±2°C for a minimum of one hour.

5. The TD shall be removed from the shipping container and examined for physical damage.

6. Operating test recordings shall be made in accordance with paragraph 2.8 after the TD has been stabilized at laboratory ambient temperature.

7. To be acceptable, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.8 1.5-Foot Drop

1. The TD shall be equipped with a protective cover (Drawing X629AS845) and shall not be energized during this test.

2. The impact surface for the drop test shall consist of a steel plate not less than 3 inches thick having a reasonably flat surface and supported in a horizontal plane over its entire bearing area by 24-inch-thick concrete.

3. The TD shall be dropped twice from a 1.5-ft height. For the first drop, the longitudinal axis of the TD shall be parallel to the impact surface; for the

second drop, the TD shall be rotated 90 degrees around its longitudinal axis from the impact point of the first drop.

4. The TD shall be examined for physical damage.

5. Operating test recordings shall be made in accordance with paragraph 2.8.

6. To be acceptable, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.9 Acoustical Noise

1. The test procedures shall be in accordance with MIL-STD-810B, Method 515.1, Procedure I.

2. The TD shall be nonoperating during this test.

3. The TD shall be exposed to a sound level of 155 dB above the reference of 2×10^{-4} dynes/cm^2 throughout the frequency spectrum from 30 to 10,000 Hz for a period of 30 minutes.

4. The TD shall be examined for physical damage.

5. Operating test recordings shall be made in accordance with paragraph 2.8.

6. To be acceptable, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.10 Aerodynamic Heating

1. The TD shall not be energized during this test.

2. A dummy warhead and guidance control group shall be mated to the TD to simulate the thermal mass of the adjoining sections and to minimize end effects. To reduce the power demand on the radiant heaters and to prevent short wavelength radiant energy from the quartz lamps from passing directly through the TD windows, the entire TD shall be coated with a coating of soot applied by an acetylene torch.

3. The TD shall be placed in a temperature chamber that has been prestabilized at a temperature of -27 ±2°C. The TD shall be maintained at this temperature for not less than 2 hours.

4. The TD shall be transferred within 2 minutes to the radiant heating facility and the TD skin temperature raised to 107 ±2°C within 4 minutes. Upon

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reaching this temperature the TD skin temperature shall be made to follow the temperature profile of Fig. 10.

5. All power shall be secured and the TD returned to laboratory ambient temperature by natural cooling.

6. The TD shall be examined for physical damage.

7. Operating test recordings shall be made in accordance with paragraph 2.8 after the TD has been stabilized at laboratory ambient temperature.

8. To be acceptable, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.11 Captive and Flight Vibration

1. Vibration fixture (Drawing DL 597AS210) shall be mounted on the vibration table with the mounting bolts tightened to a torque of 20 ±1 lb-ft.

2. The TD shall be mounted on the fixture with the mounting clamps torqued to 100 ±5 lb-in.

3. The TD and fixture shall be temperature-conditioned for at least 4 hours at the test temperatures.

4. The TD shall be subjected to the vibration levels shown in Fig. 6 for a period of not less than 30 minutes along each of the three major axes shown in Fig. 4.

5. The operating duty cycle of the TD shall be energized for 2 minutes and then de-energized for 2 minutes.

6. TD windows shall be covered with a suitable optically opaque material.

7. The operating test recordings of paragraph 2.8 shall be made during vibration while the TD is energized.

8. The vibration shall be applied with the TD temperature stabilized at laboratory ambient temperature, at -40 ±2°C, and at +60 ±2°C.

9. The TD shall be examined for physical damage.

10. Operating recordings shall be made in accordance with paragraph 2.8 after the TD has been stabilized at laboratory ambient temperature.

11. Criteria for passing this test shall include absence of fire pulse; lower TD inhibit rates and threshold rates than those specified in NAS-2262; and, after completion of the test, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.12 Humidity (Nonoperating)

The TD shall be equipped with dummy connectors and end plates that simulate the missile round configuration interfaces and be subjected to the test of MIL-STD-810, Method 507, Procedure I, modified as follows:

1. The TD shall be placed in a humidity chamber meeting the requirements of MIL-STD-810, Method 507, at a temperature of 15 ±5°C and a relative humidity of 95 ±5%. The temperature and relative humidity shall be changed over a 1-hour period to 60°C (+0, -6), and 70 ±20% and be maintained at these levels for 3 hours. Over a 1-hour period, the temperature and relative humidity shall be changed back to 15 ±5°C and 95 ±5% and maintained for 3 hours. The TD shall be subjected to 26 of the above cycles. It may be stored over weekend periods at 23 ±10°C and 50 ±30% relative humidity.

2. The TD shall be examined for physical damage.

3. Operating recordings shall be made in accordance with paragraph 2.8 within 15 minutes of completion of the last cycle.

4. To be acceptable, the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.13 Low Temperature Storage

The TD shall be subjected to the test of MIL-STD-810, Method 502, modified as follows:

1. The TD shall be placed in a suitable low temperature chamber at ambient temperature, and the chamber temperature shall be decreased at a uniform rate such that the temperature is -40 ±2°C at the end of 4 hours. This temperature shall be maintained for not less than 72 hours.

2. The chamber temperature shall then be increased at a uniform rate such that the temperature is -5 ±2°C at the end of 4 hours.

3. The TD shall be energized, and the operability test of paragraph 3.4 shall be conducted during the last 15 minutes of the test.

4. The TD shall be examined for physical damage.

5. To be acceptable, the TD must meet the requirements of paragraph 3.4, as defined in NAS-2262.

3.14 Low Temperature Operation

For this test, which may be combined with the test of paragraph 3.15, the TD shall be subjected to the test of MIL-STD-810, Method 502, modified as follows:

1. The TD shall be placed in a suitable low temperature chamber at ambient temperature, and the temperature shall be decreased at a uniform rate such that the temperature is -52 ±2°C at the end of 2 hours. The temperature shall be maintained at this level for 2 hours.

2. The TD shall be energized, and the test of 3.4 shall be conducted during the last 15 minutes of the test.

3. The criteria for passing this test are the same as those specified in paragraph 3.15, item 5.

3.15 Low Pressure Operation (Altitude Simulation)

1. The TD shall be installed in a temperature-altitude chamber, and the TD windows shall be covered with suitable optically opaque material.

2. The operating test recordings of paragraph 2.8 shall be made.

3. The temperature and pressure shall be reduced to -52 ±2°C and 55,000 ±1,000 ft altitude, respectively. After stabilization at this condition for 2 hours, the TD shall be energized, and a recording shall be made while the chamber pressure is changed to 80,000 ±1,000 ft altitude at the maximum rate of the chamber. The TD shall be maintained at this condition for 2 minutes, and the recording shall be monitored to verify satisfactory TD performance. The chamber shall then be returned to laboratory ambient temperature.

4. The TD shall be examined for physical damage.

5. The criteria for passing this test shall include absence of fire pulse; lower TD inhibit and threshold rates than those specified in NAS-2262; and the TD shall meet the requirements of paragraphs 3.1, 3.3, and 3.4 following the test.

3.16 High Temperature Storage

The TD shall be subjected to the test of MIL-STD-810, Method 501, modified as follows:

1. The TD shall be placed in a suitable high temperature chamber, with the internal chamber temperature being controlled in accordance with the temperature profile of Fig. 7. The TD shall be subjected to the temperature profile twice, for a total test time of 48 hours. Heating and cooling shall be such that the TD is not exposed to direct radiant or air stream heating or nonuniform cooling.

2. The TD shall be removed from the chamber and subjected to the operability test of paragraph 3.4 within 15 minutes.

3. The TD shall be examined for physical damage.

4. To be acceptable, the TD must meet the requirements of paragraph 3.4, as defined in XAS-2262.

3.17 High Temperature Operation

The TD shall be tested in accordance with MIL-STD-810, Method 501, modified as follows:

1. The TD shall be placed in a suitable high temperature chamber at standard room temperature, and the temperature shall be increased at a uniform rate such that the temperature is +62 ±2°C at the end of 2 hours. The temperature shall be maintained at this level for 1 hour. Heating shall be such that the TD is not exposed to direct radiant or air stream heating.

2. The TD shall be energized, and the test of paragraph 3.4 shall be conducted during the last 15 minutes of the test.

3. The TD shall be examined for physical damage.

4. To be acceptable, the TD must meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.18 Temperature and Humidity (Information Only)

1. The de-energized TD shall be mated with end caps and dummy connectors to simulate the missile configuration interfaces.

2. The TD shall be placed in a temperature and humidity chamber and be subjected to one complete 14-day "JAN" temperature and humidity cycle as specified in MIL-STD-331, Test 105.

3. The TD shall be examined for evidence of corrosion, internal condensation, and leakage.

4. Operating recordings shall be made in accordance with paragraph 2.8 after the TD has been stabilized at laboratory ambient temperature.

5. To be acceptable, the TD must meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.19 Vacuum-Steam-Pressure (Information Only)

1. The de-energized TD shall be mated with end caps and dummy connectors to simulate the missile configuration interfaces.

2. The TD shall be placed in the vacuum-steam-pressure chamber and be subjected to 1,000 15-minute vacuum-steam-pressure cycles as specified in MIL-STD-331, Test 106.

3. The TD shall be examined for evidence of corrosion, internal condensation, and leakage.

4. Operating recordings shall be made in accordance with paragraph 2.8 after the TD has been stabilized at laboratory ambient temperature.

5. To be acceptable, the TD must meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.20 Static Bending Moment (Information Only)

1. The de-energized TD shall be secured for this test by a holding fixture (Drawing 2409031) mounted on a rigid structure capable of withstanding a bending moment exceeding 40,000 lb-in.

2. The lever arm (Drawing 2409032) shall be mounted on the forward end of the TD, using one of the two TD coupling rings. This assembly shall be mounted on the holding fixture as shown in Fig. 8 using the other coupling ring, with the coupling-ring screws positioned opposite the applied force and tightened to a torque of 100 ±5 lb-in.

3. Force shall be applied at a rate of 180 to 350 lb/sec at a point 11.900 ±0.062 inches from the forward end of the TD. When a force of 1,780 pounds has been obtained, the force shall be removed within 1.0 second. The TD shall then be removed from the fixture and examined.

4. To be acceptable, the TD must meet the requirements of paragraphs 3.1, 3.3, and 3.4.

3.21 Thermal Battery Firing

1. The four TD devices to be tested shall be divided into two temperature groups. The first group shall be temperature-conditioned at +62 ±2°C for a minimum of 1 hour; the second group shall be conditioned at -52 ±2°C for a minimum of 1 hour.

2. The TD and test equipment shall be connected as indicated in Fig. 9, and the battery match resistance shall be measured and recorded prior to activation.

3. A 0.75±0.20-ampere current pulse shall be applied to the battery ignition circuit (J1-9, Sk 639AS102) for a duration of not less than 50 ms.

4. For the life of the battery, the following parameters shall be recorded on a strip chart recorder at a chart speed of 0.5 to 1.0 in/sec:

- Thresholds with a dark background condition (J-3, Pin C)
- Inhibits with a dark background condition (J-3, Pin F)
- Thermal battery voltage (J-3, Pin X)

5. Within 15 seconds of battery initiation, the detection sensitivity of one quadrant at zero degree azimuth shall be determined as specified in XAS-2262.

6. The transmitter or receiver shall be masked off until 90±5 seconds after battery initiation, and step 5 shall be repeated.

7. The strip chart shall be examined for thresholds or inhibits that exceed the false alarm or inhibit rates specified in XAS-2262. Thresholds that occur during the detection sensitivity tests of steps 5 and 6 do not apply.

8. To be acceptable, the TD must meet the requirements of paragraph 3.4, as defined in XAS-2262.

3.22 Reliability Test Program

1. The reliability test program shall be conducted as shown in the flow diagram and program reference tabulation of Fig. 3.

2. Six TD shall be subjected to the 10 test cycles for a test-equivalent of 60

flight missions, which will result in a demonstrated reliability factor of 0.985 with a 60% confidence level if no failures are encountered.

3.23 Engineering Test Program

1. An engineering test program shall be conducted for information only, as shown in Fig. 2. The six TD subjected to this test are considered to be expended and shall not be used for flight tests.

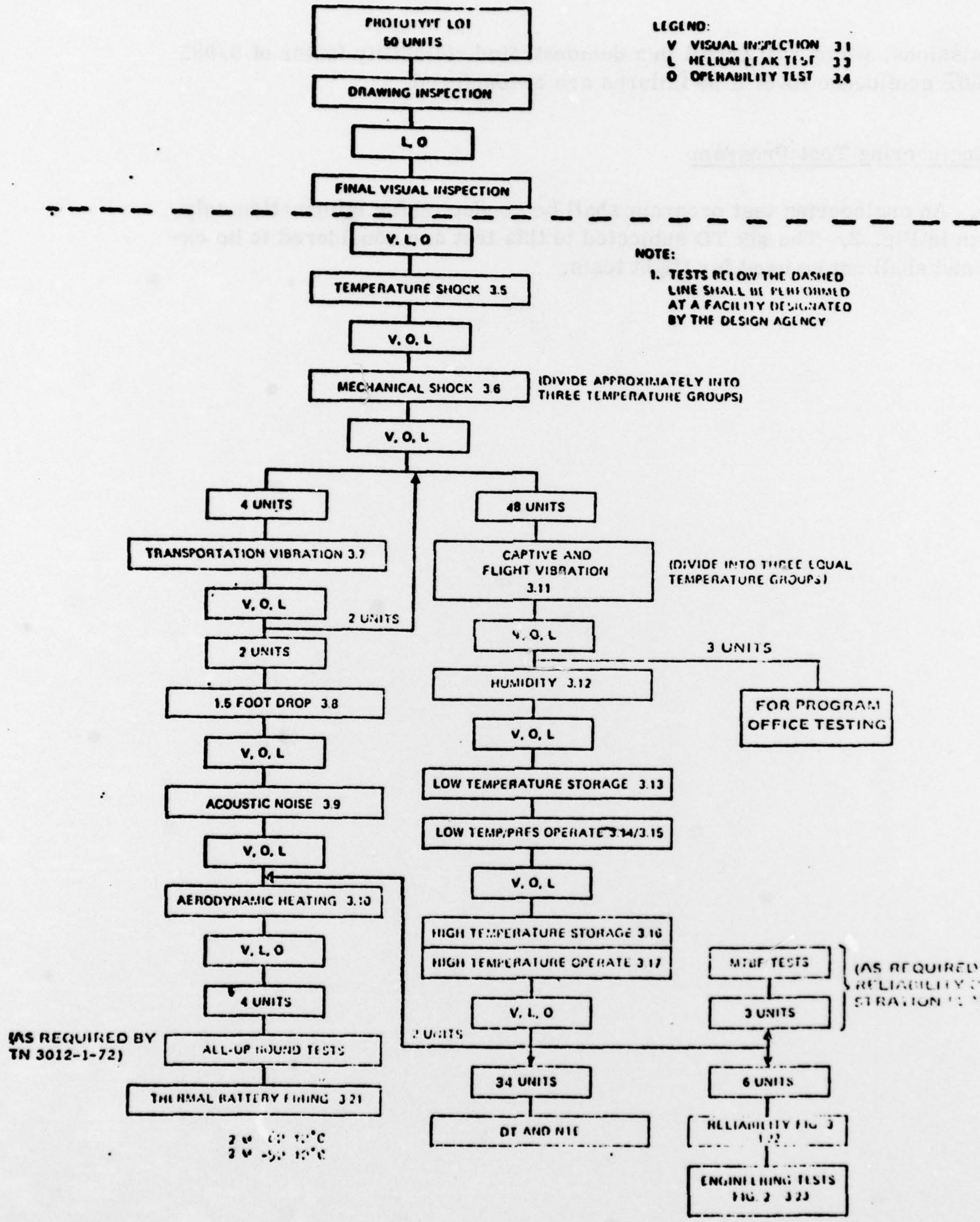


FIG. 1. Qualification Test Sequence.

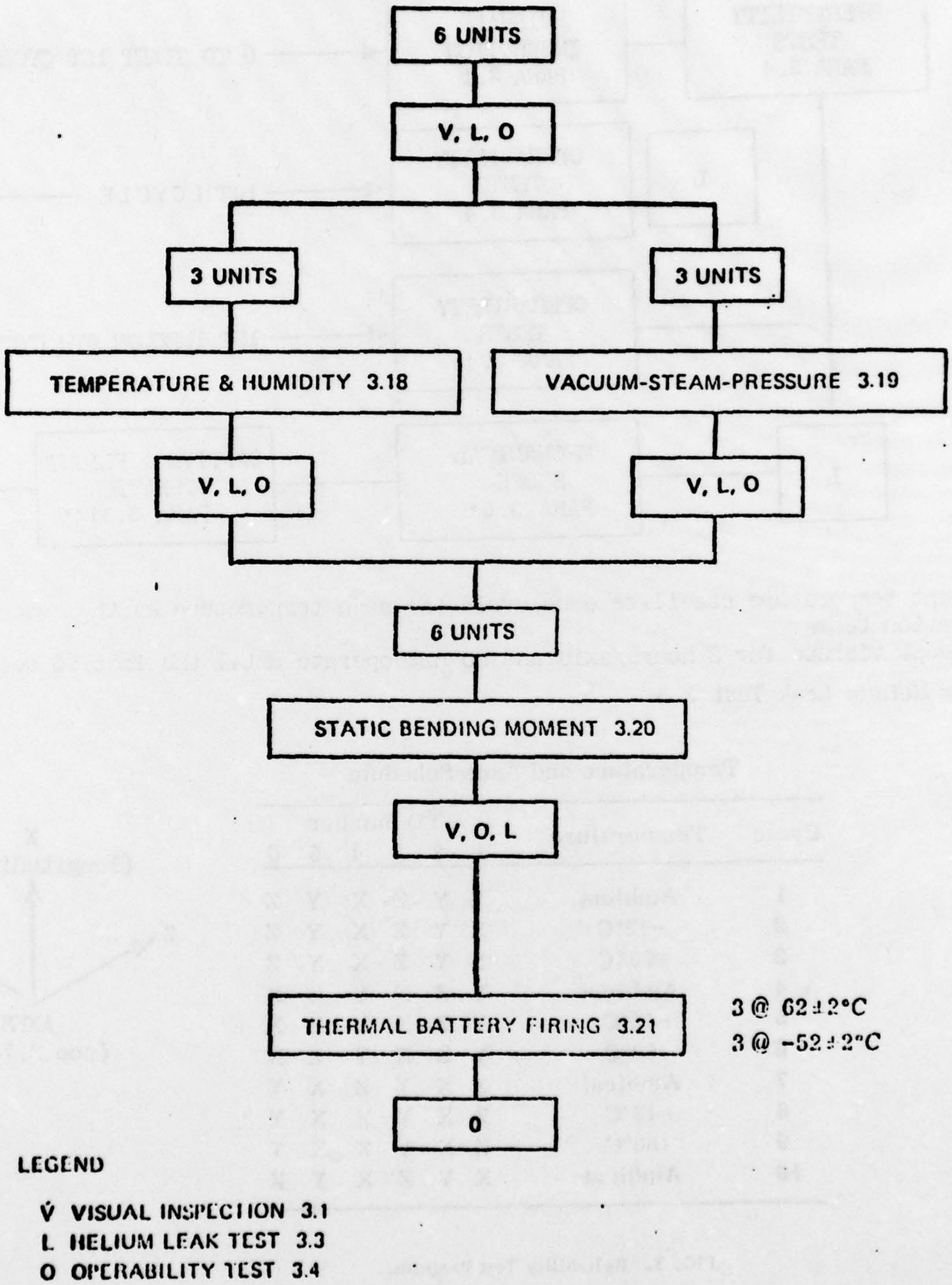
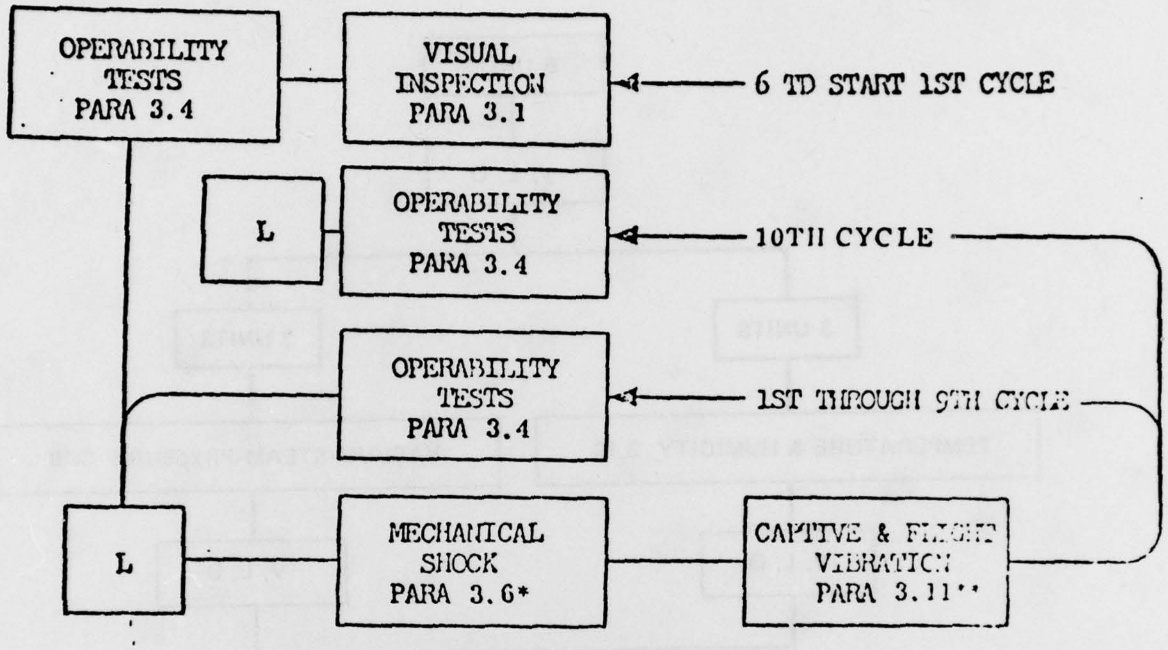


FIG. 2. Engineering Test Sequence.



*Except temperature stabilize each cycle the same temperature as the succeeding vibration tests.
**Except vibrate for 2 hours/axis and do not operate until the last 60 seconds.

L = Helium Leak Test 3.3

Temperature and Axes Schedule

Cycle	Temperature	TD number 1	2	3	4	5	6
1	Ambient	X	Y	Z	X	Y	Z
2	-42°C	X	Y	Z	X	Y	Z
3	+60°C	X	Y	Z	X	Y	Z
4	Ambient	Y	Z	X	Y	Z	X
5	-42°C	Y	Z	X	Y	Z	X
6	+60°C	Y	Z	X	Y	Z	X
7	Ambient	Z	X	Y	Z	X	Y
8	-42°C	Z	X	Y	Z	X	Y
9	+60°C	Z	X	Y	Z	X	Y
10	Ambient	X	Y	Z	X	Y	Z

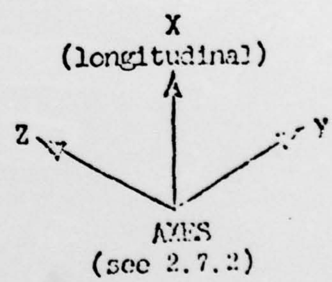


FIG. 3. Reliability Test Program.

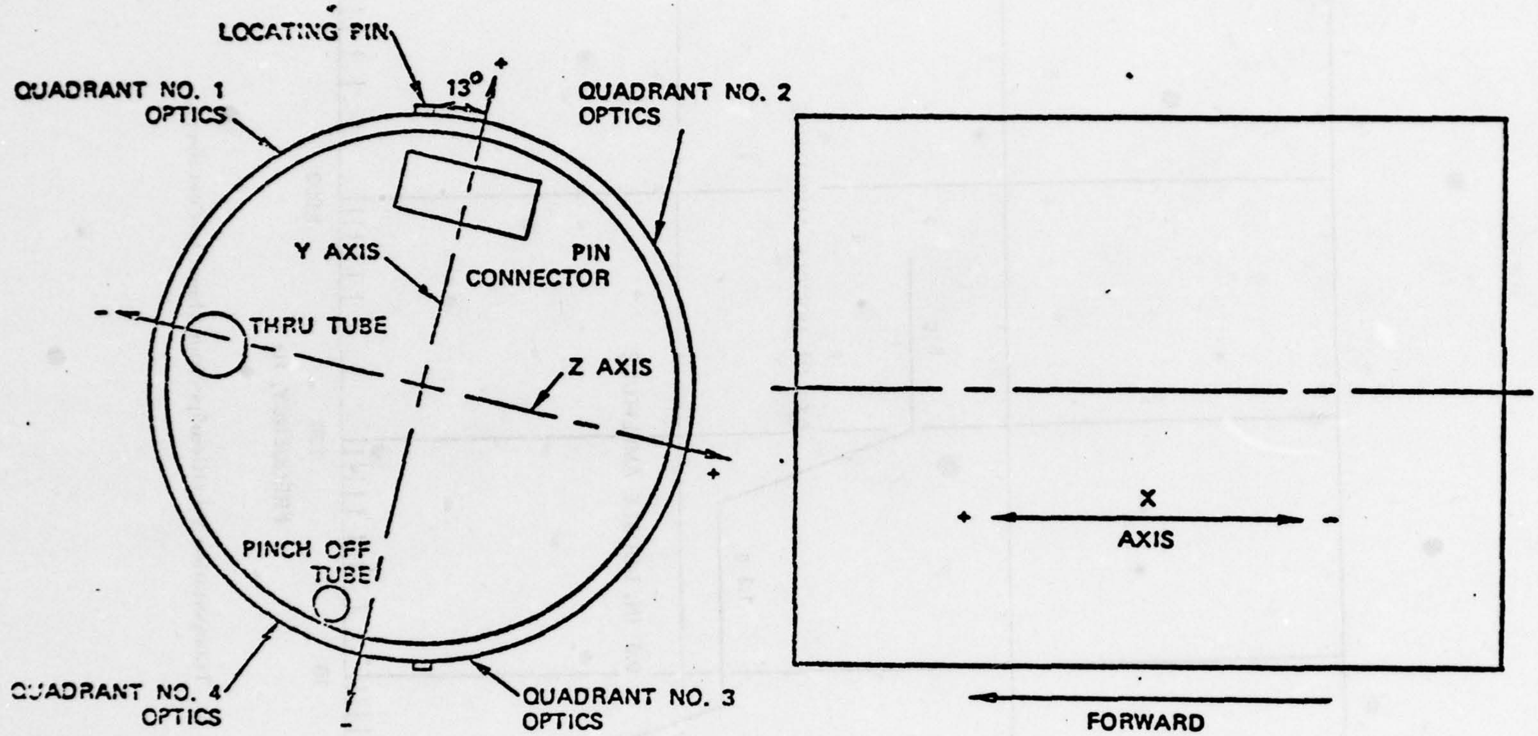


FIG. 4. Major Axes Designation.

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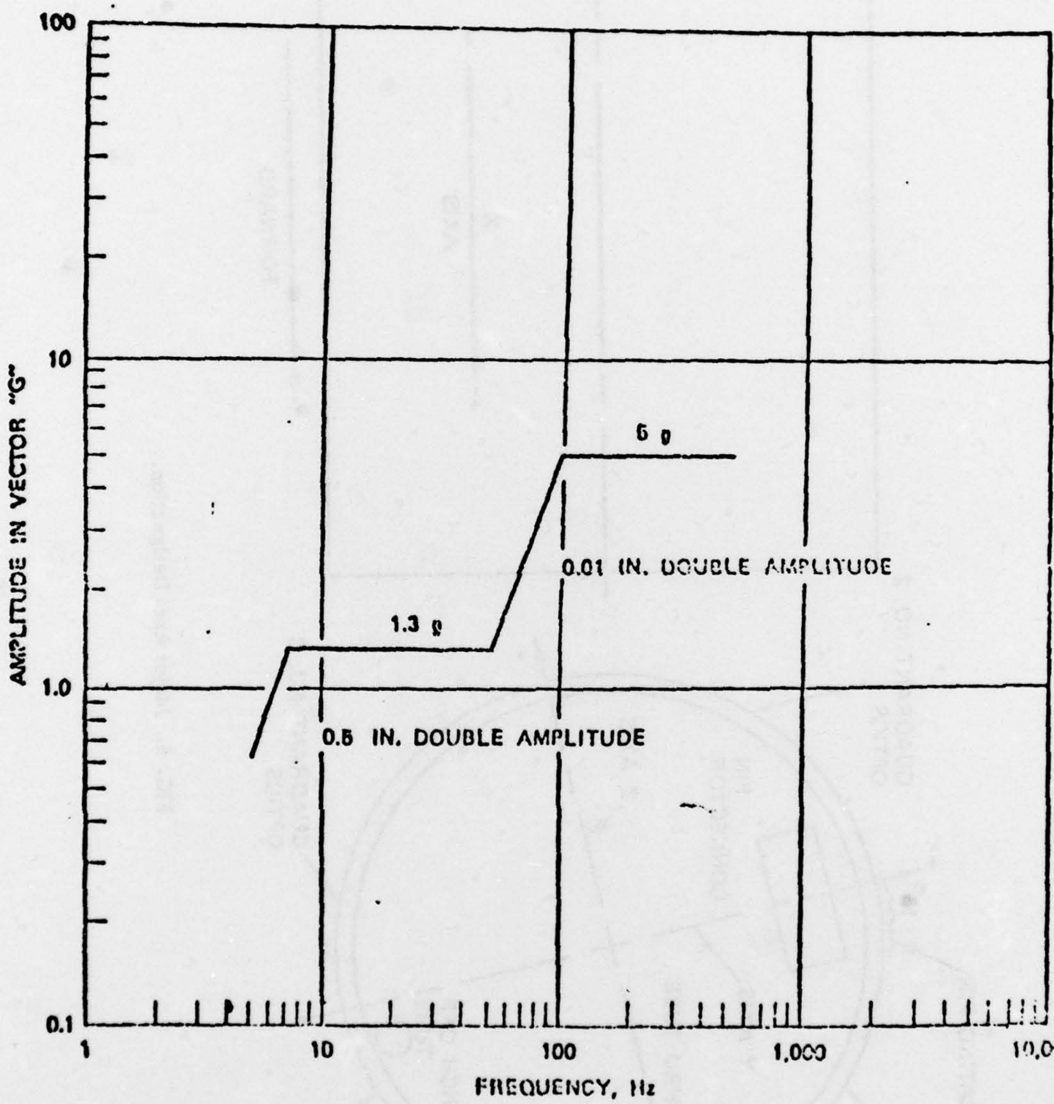

FIG. 5. Transportation Vibration Spectrum (Input to Container).

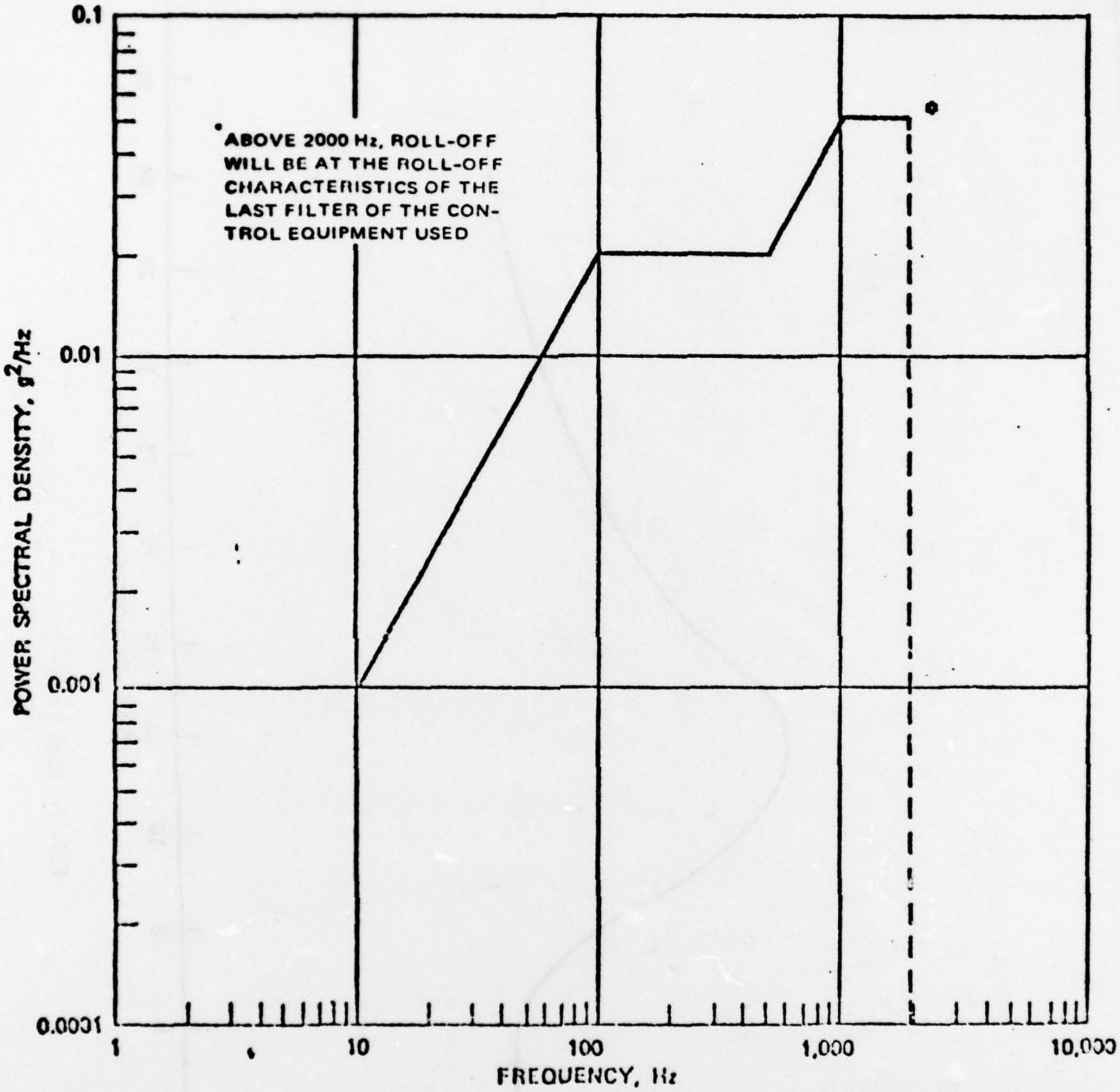

FIG. 6. Captive and Free Flight Vibration Spectrum.

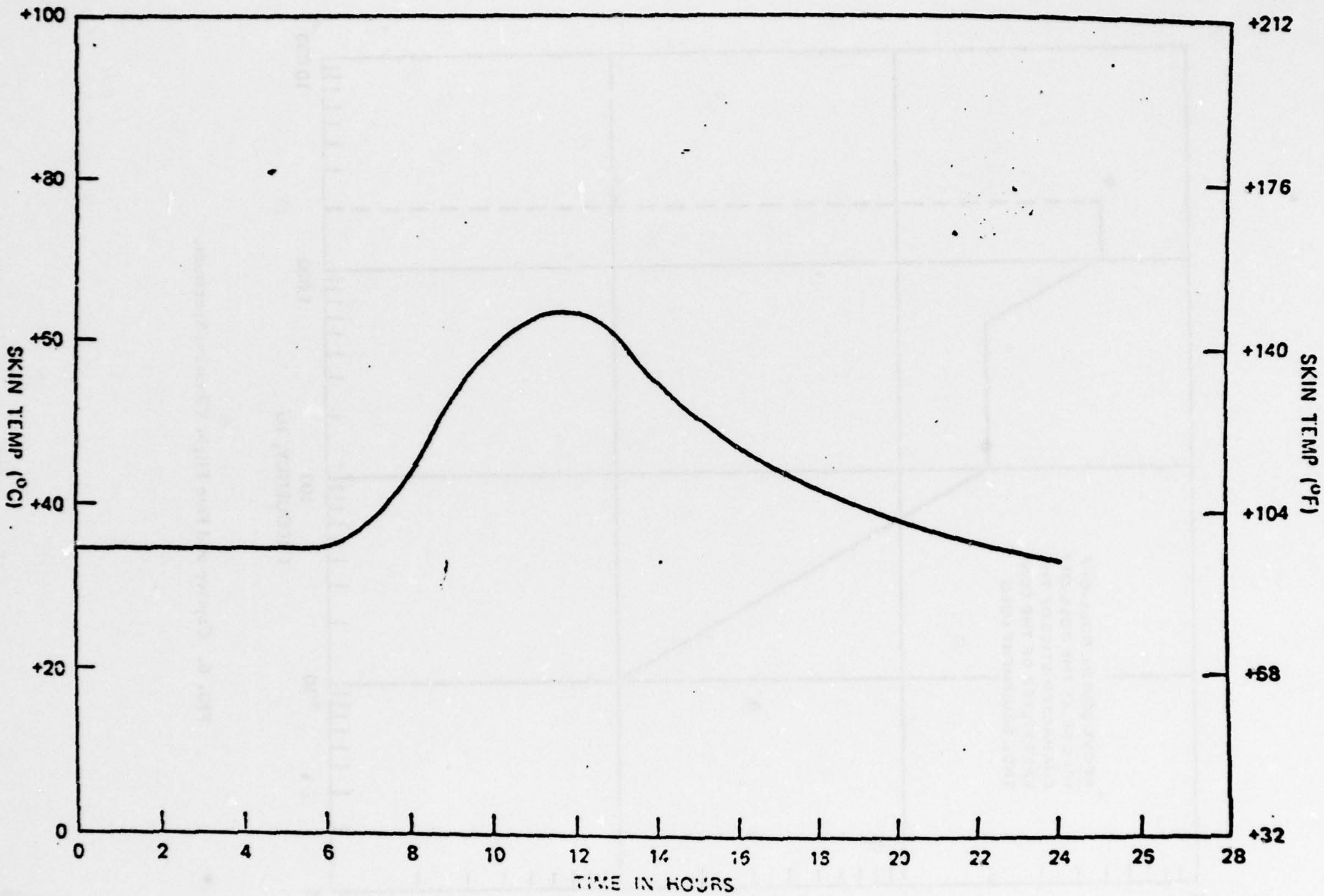

FIG. 7. High Temperature Storage Profile.

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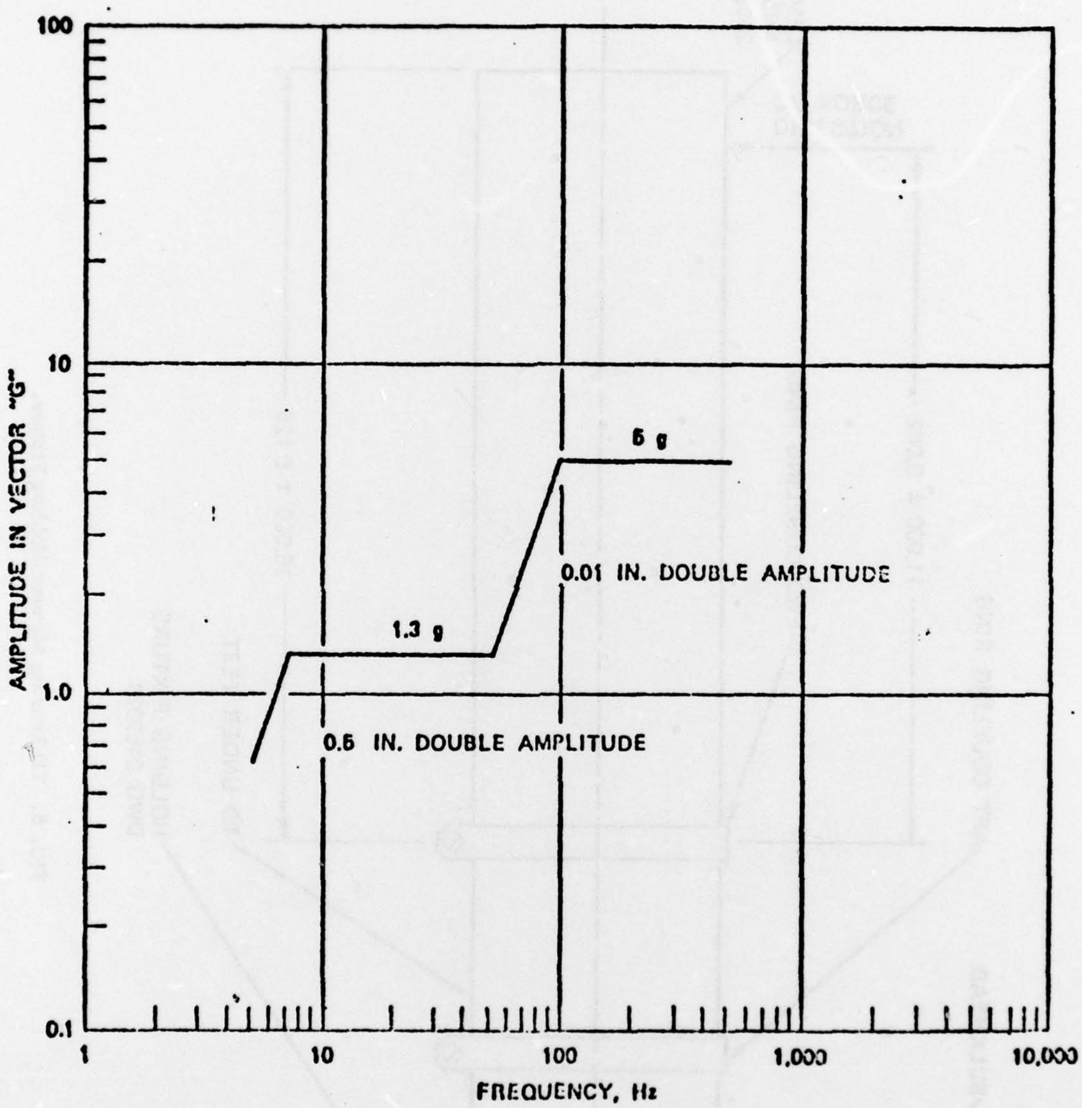

FIG. 5. Transportation Vibration Spectrum (Input to Container).

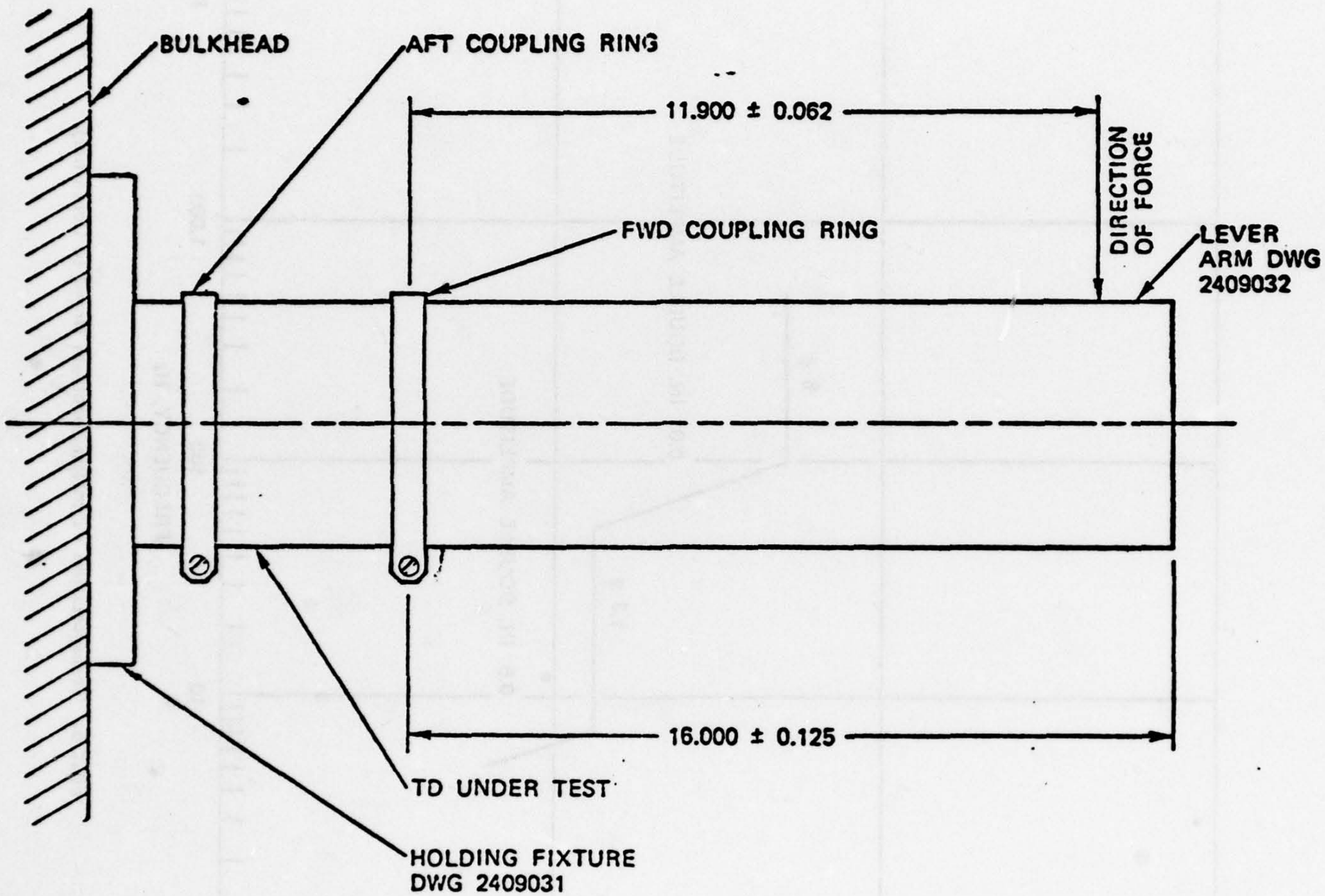

FIG. 8. TD Bending Moment Holding Fixture.

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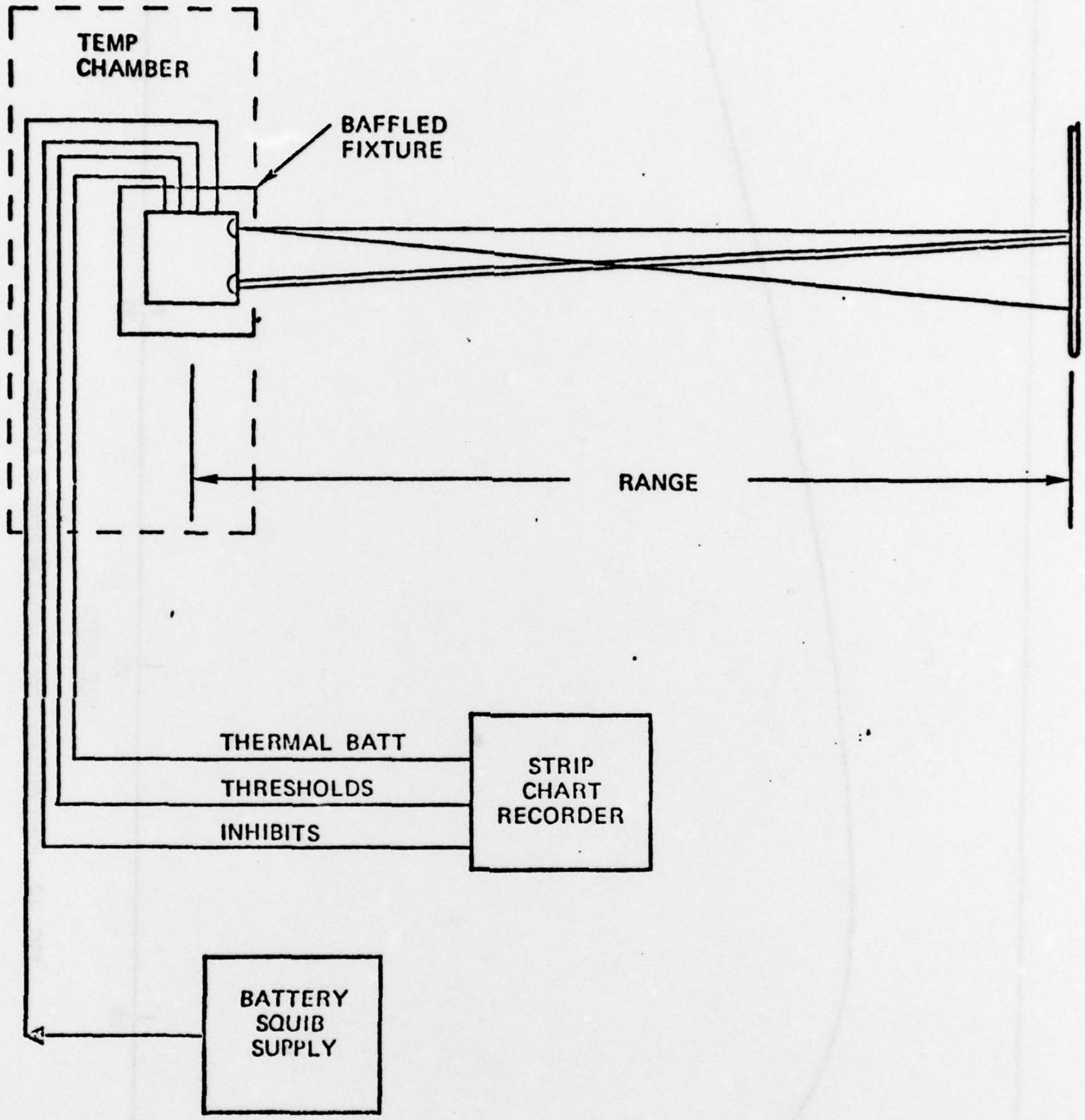

FIG. 9. Thermal Battery Performance Test Setup.

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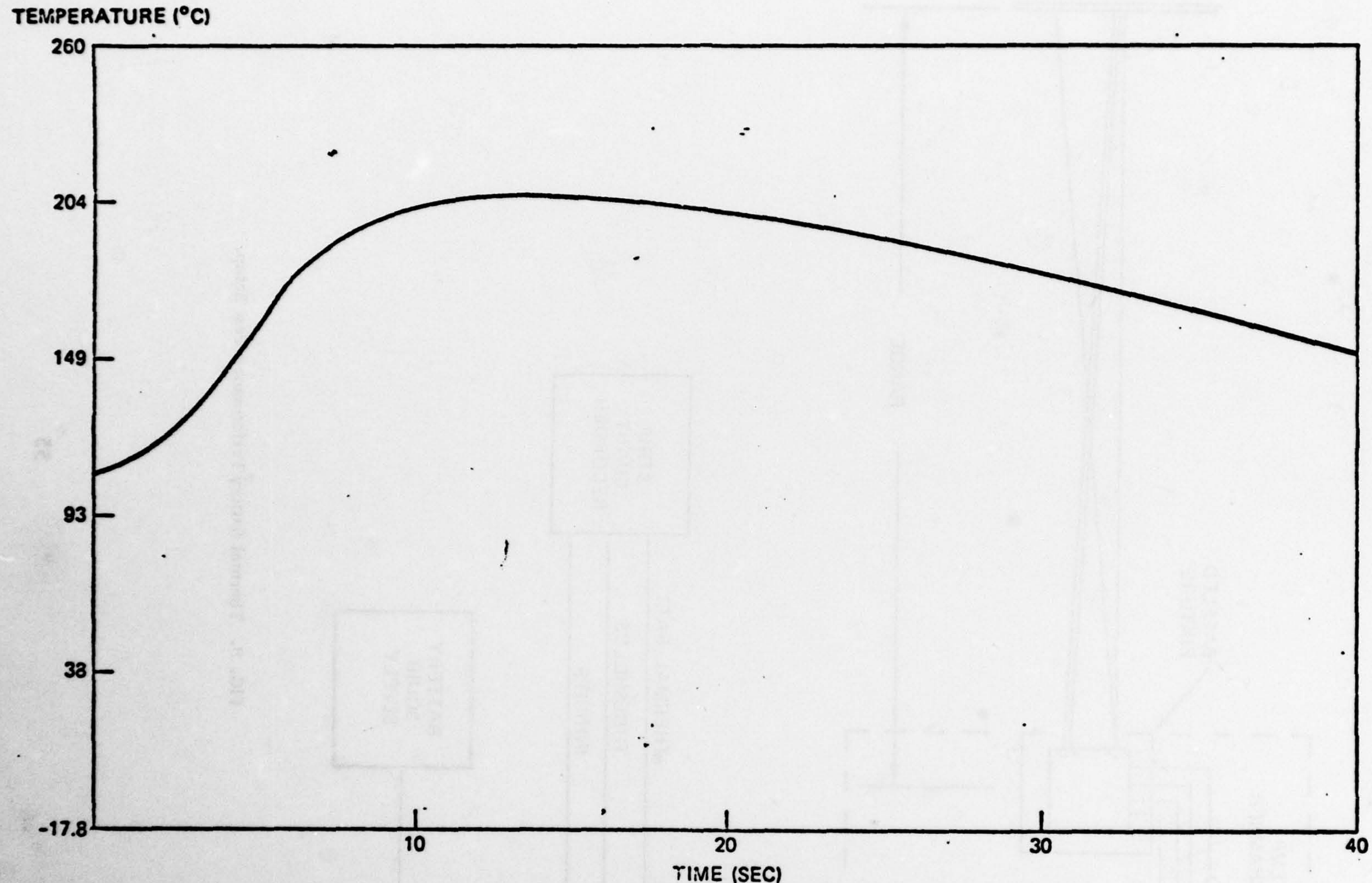

FIG. 10. High Altitude Free Flight Temperature Profile.

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